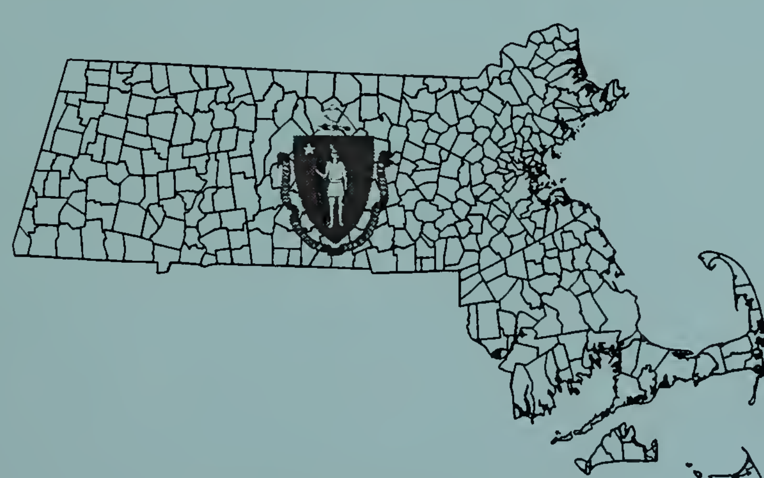
Massachusetts 1998 Air Quality Report

Executive Office of Environmental Affairs
Department of Environmental Protection
Bureau of Waste Prevention
Division of Planning and Evaluation



Air Assessment Branch
Wall Experiment Station
37 Shattuck Street
Lawrence, MA 01843

ACKNOWLEDGEMENTS

The data in this report represents the work of the Air Assessment Branch to collect representative, complete, and accurate air quality data throughout the Commonwealth.

Primary authorship of the 1998 annual report is attributed to John Lane.

The following MADEP staff also contributed to its publication: Leslie Collyer, Richard Driscoll, Ross Edward, Richard Fields, Thomas McGrath, Robert Quevillon, Ken Santlal, Nancy Seidman, Jerry Sheehan, Ann Sorensen, Margaret Valis, and Leah Weiss.

The photograph on the cover is the air monitoring station located in Easton at Borderland State Park, which was taken by Robert Quevillon.

This document is available in Adobe Acrobat PDF format from the MADEP website. The address is http://www.state.ma.us/dep/.

Inquiries may be directed to:
John Lane
Air Assessment Branch
Wall Experiment Station
Lawrence, MA 01843-1343
(978) 975-1138
email: John.Lane@state.ma.us

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List of Abbreviations

AAB................Air Assessment Branch
AIRS...............Aerometric Information Retrieval System
BP....................Barometric Pressure
CFR ....Code of Federal Regulations
CO ....Carbon Monoxide
DVMT ....Daily Vehicle Miles Traveled
MADEP..........Massachusetts Department of Environmental Protection
mg/m^3..................milligrams per cubic meter
NAAQS..........National Ambient Air Quality Standard
NADP.............National Atmospheric Deposition Program
NAMS ....National Air Monitoring Stations
NESCAUM ....Northeast States for Coordinated Air Use Management
NO..................Nitrogen Oxide
NOx................Nitrogen Oxides
NOy ....Total Reactive Oxidized Nitrogen
NO2................Nitrogen Dioxide
O3...................Ozone
PAMS.............Photochemical Assessment Monitoring Stations
Pb....................Lead
pH...................Concentration of hydrogen cations (H^+) in solution. An indicator of acidity.
ppb..................parts per billion by volume
ppm.................parts per million by volume
PM2.5 ....Particulate matter 2.5 microns
PM10..............Particulate matter 10 microns
PSI..................Pollutant Standards Index
QA/QC...........Quality Assurance and Quality Control
RH ....Relative Humidity
SIP..................State Implementation Plan
SLAMS...........State and Local Air Monitoring Stations
SO2.................Sulfur Dioxide
TSP.................Total Suspended Particulates
ug/m^3..............micrograms per cubic meter
USEPA ....United States Environmental Protection Agency
VOC................Volatile Organic Compounds
WS/WD..........Wind Speed/Wind Direction

Executive Summary

Introduction

The Massachusetts Department of Environmental Protection (MADEP) monitors the ambient air quality and implements emissions controls, as necessary, for pollutants that adversely affect the public health and welfare. This report provides summary information and statistics of air monitoring activities for 1998, including long term trends of air quality and emissions data.

Criteria pollutant monitoring

During 1998, MADEP analyzed the ambient air for ozone (O3), sulfur dioxide (SO2), nitrogen dioxide (NO2), carbon monoxide (CO), particulate matter less than or equal to 10 microns (PM10), and lead (Pb). These are criteria pollutants which states are mandated to monitor by the U.S. Environmental Protection Agency (USEPA).

Enhanced ozone monitoring

Enhanced ozone monitoring (or PAMS, for Photochemical Assessment Monitoring Stations) continued during 1998, and included the measurement of volatile organic compounds (VOC). VOC are contributors to the formation of ozone and include pollutants known or suspected to cause cancer or other serious health effects, such as birth defects.

A new monitoring network established

PM2.5, which comprises very fine particulates (smaller than 2.5 microns), has been added as a particulate standard, in addition to the PM10 standard. The PM2.5 monitoring network was established during November and December 1998. Eighteen sites were established in 15 cities throughout Massachusetts. Preliminary samples were taken to test the monitors and sampling procedures. Data will be reported beginning January 1999.

How the data is used

The ambient monitoring data is used to determine whether Massachusetts is meeting the public health standards, report the state of air quality in the Commonwealth, and assess whether the air pollution control strategies in place are reducing the public health and environmental impacts of air pollutants.

Evaluating air quality trends

Air quality is influenced by many factors. Massachusetts and neighboring states have initiated many efforts to reduce the level of pollutant emissions going into the air. These have resulted in significant air quality improvements.

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Evaluating air quality trends, Continued

The state of the economy, as reflected by industrial and commercial activity - and the resultant levels of emissions, as well as meteorological conditions, should be considered when evaluating ozone trends. For example, while the Massachusetts economy has been growing in recent years, good meteorological conditions prevented high O3 levels. If meteorological conditions had been more conducive to O3 formation (such as warmer temperatures or different wind patterns), the levels would have been higher.

While current data trends are downward for many pollutants, MADEP believes that existing emission control programs must be maintained and improved to sustain the improvements to date and offset expected growth in emissions. The challenge is to effectively balance the goals of cleaner air and a strong economy.

Ozone ambient air trend

O3 has two air quality standards: one for O3 values averaged over a 1-hour period, and a new standard averaged over an 8-hour period. The 10-year trend shows the number of 1-hour violations has substantially decreased, with only one site in violation for 1998. In June 1999 the USEPA revoked the 1-hour standard for portions of Massachusetts as part of the plan to implement the new 8-hour standard. Only the western region of Massachusetts, including Berkshire, Franklin, Hampden, and Hampshire counties, is classified as in non-attainment of the 1-hour standard.

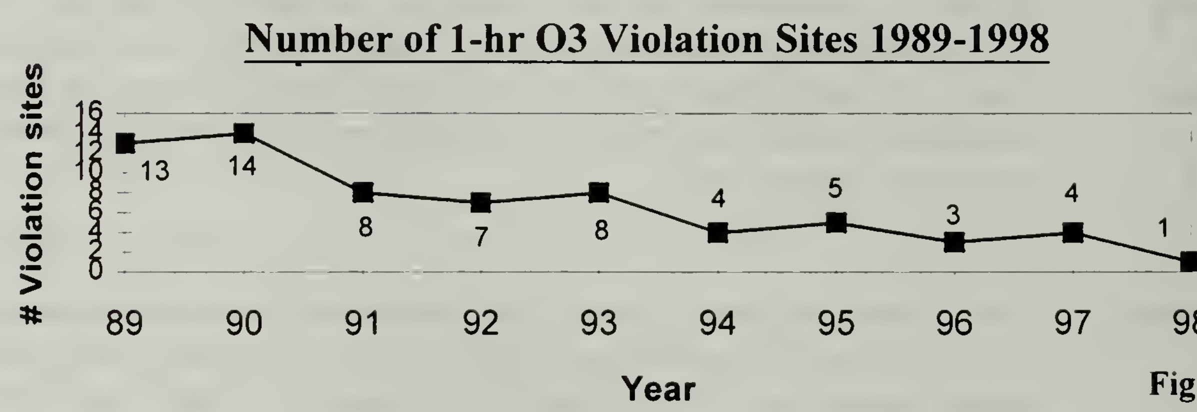

Figure 1

The 8-hour standard was promulgated in 1997 in response to studies that indicate that longer-term exposures to lower O3 levels cause adverse health effects. Preliminary analysis, using data for 1996-1998, indicates that ten of the fifteen O3 monitoring sites would have violated the standard (see page 27 for more on the 8-hour O3 violation status).

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CO ambient air trend

The CO trend of 8-hour values is downward for the 10-year period. CO, as indicated by the 8-hour 2nd-maximum concentration, has decreased by 45% over the 10-year period. Massachusetts is below the standard.

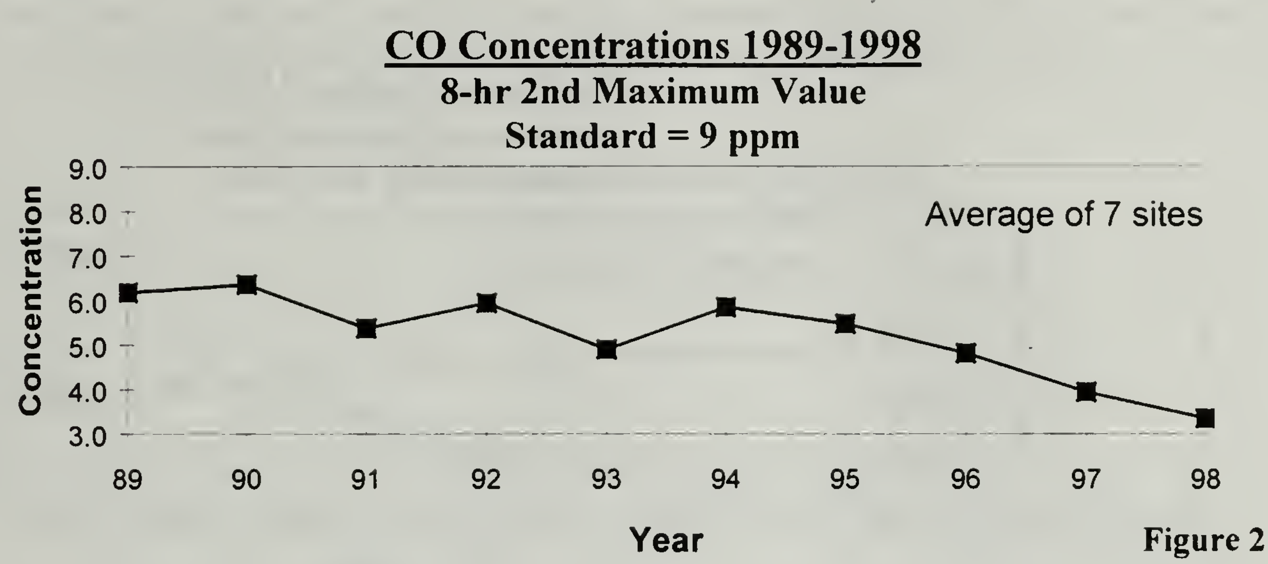

Figure 2

NO2 ambient air trend

The NO2 trend has been stable the last few years, but over the 10-year period the annual arithmetic mean concentration has decreased by 19%. Massachusetts is below the standard.

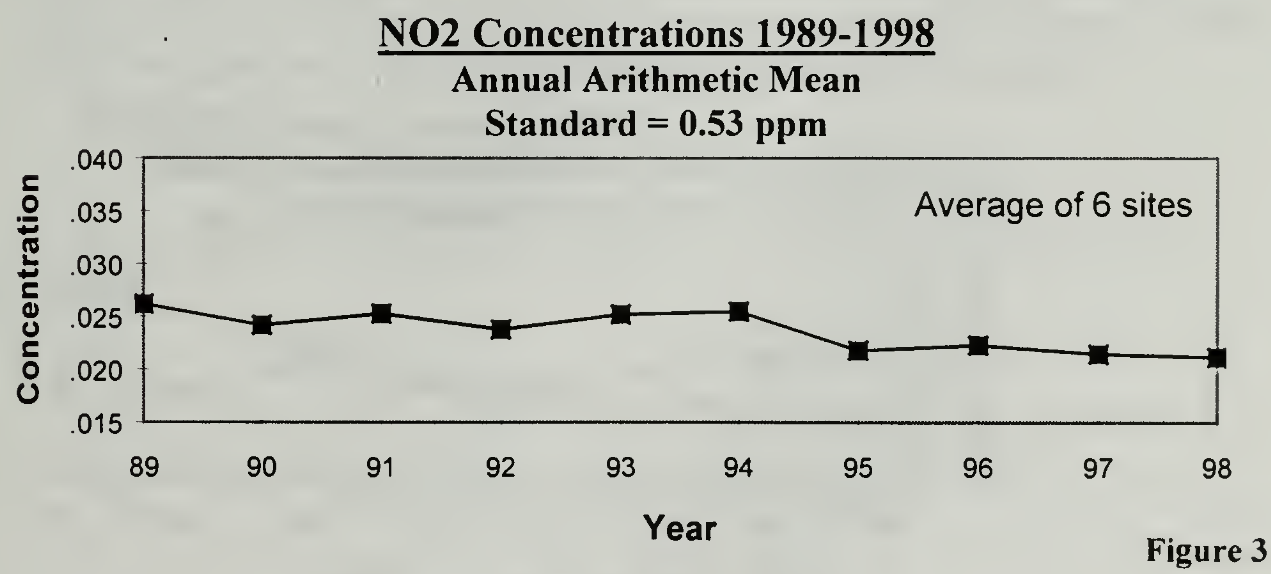

Figure 3

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SO2 ambient air trend

The SO2 trend has been stable the last few years, but over the 10-year period the annual arithmetic mean concentration has decreased by 55%. Massachusetts is below the standard.

SO2 Concentrations 1989-1998
Annual Arithmetic Mean
Standard = 0.03 ppm

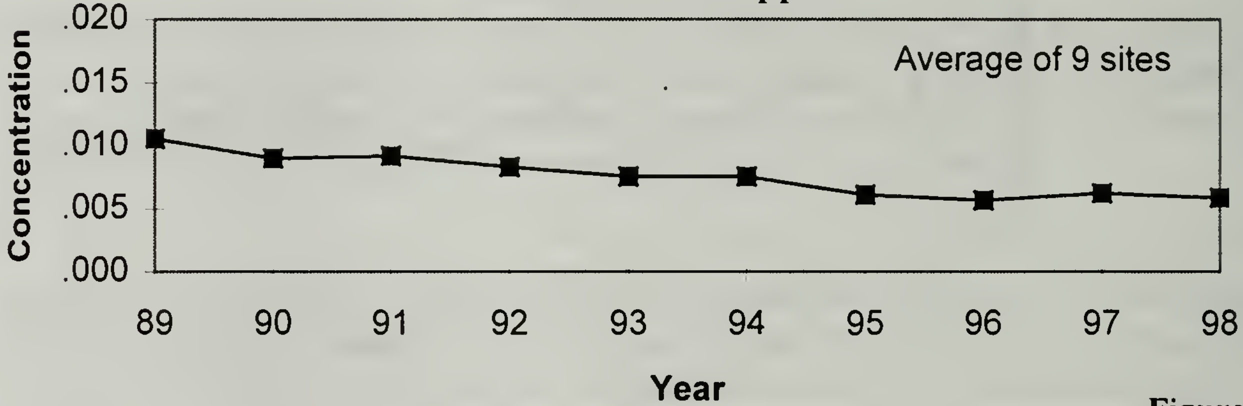

Figure 4

PM10 ambient air trend

The PM10 trend has been stable the last few years, but over the 10-year period the annual arithmetic mean concentration has decreased by 19%. Massachusetts is below the standard.

PM10 Concentrations 1989-1998
Annual Arithmetic Mean
Standard = 50 ug/m3

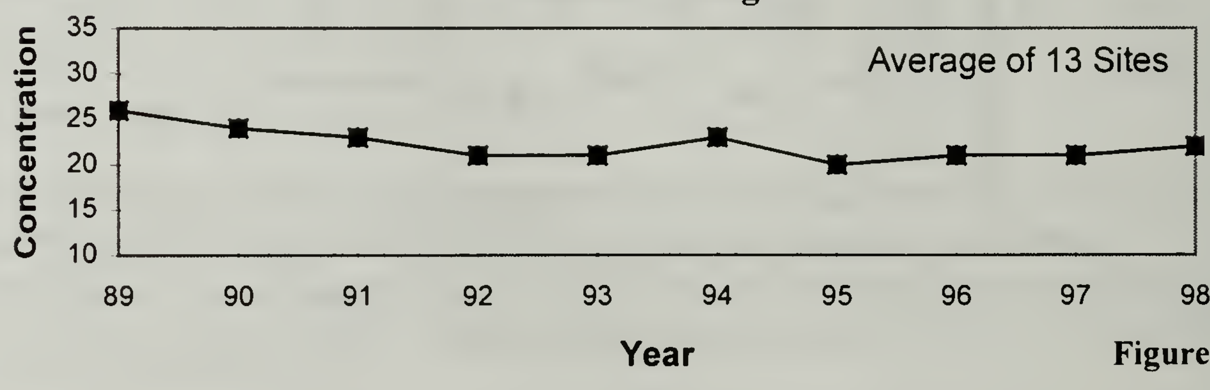

Figure 5

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Lead ambient air trend

As required by USEPA, lead (Pb) monitoring was reinstituted at one site in 1998 after being discontinued in 1995. As the figure indicates, the concentration of Pb in the air decreased substantially over the 10-year period 1986-1995. This result is attributed to the use of unleaded gasoline in motor vehicles, which are the primary source of airborne lead emissions. Massachusetts is below the standard.

Pb Concentrations 1986-1995
Annual Arithmetic Mean
Standard = 1.5ug/m3

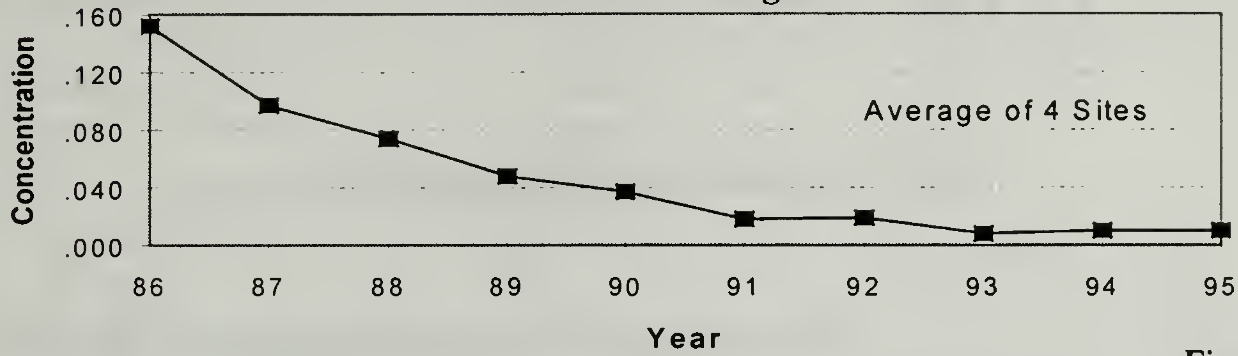

Figure 6

PAMS monitoring

PAMS monitoring for VOC has been conducted for five years. Analysis of the ambient concentration levels indicate a decline in certain toxic VOC. There have been substantial decreases in benzene, ethlybenzene, toluene, and xylene. The decreases are probably the result of the use of reformulated gas beginning in 1995, which has significantly reduced the emissions of these toxic pollutants.

Benzene Concentrations 1994-1997
Annual Arithmetic Mean of 24-hour Values

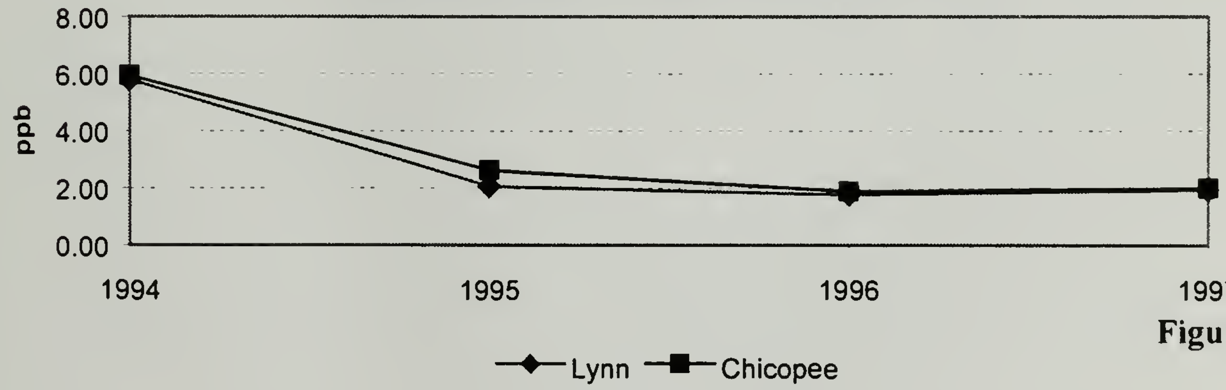

Figure 7

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Point source emission trends

Point sources are large manufacturing facilities and power plants. There have been substantial decreases in VOC, SO2, and oxides of nitrogen (NOx) emissions from these sources during the period 1990-1996. CO emissions have remained relatively constant throughout this period.

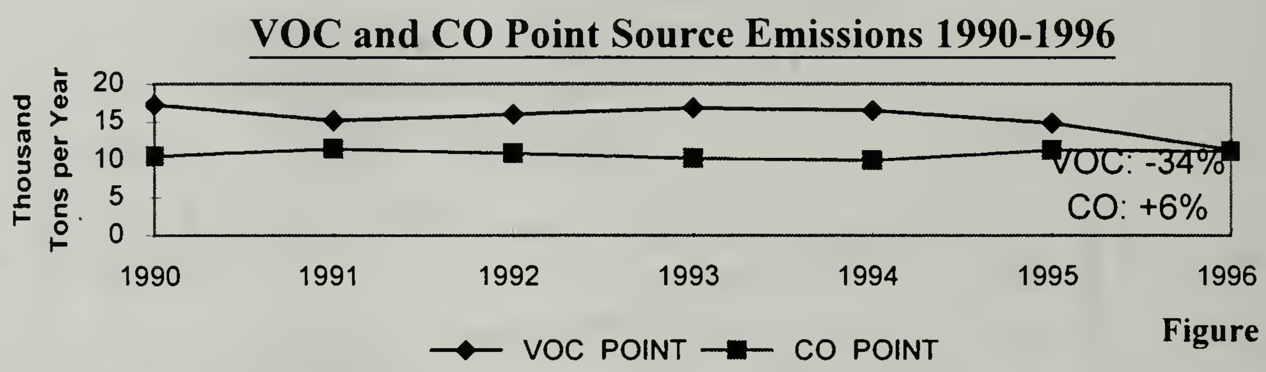

Figure 8

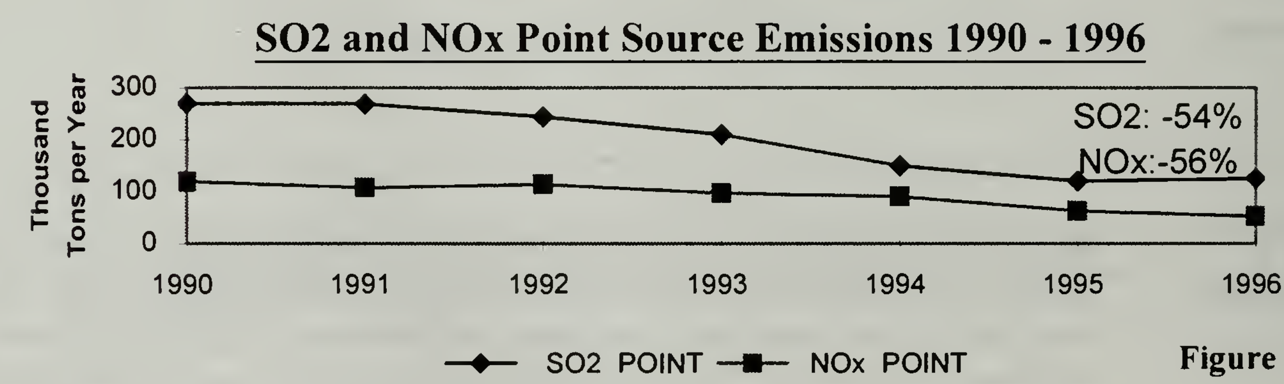

Figure 9

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On-road mobile source emission trends

On-road mobile sources include common on-road vehicles such as autos, trucks, motorcycles, and buses. Figure 10 shows the 1990-1996 trends for on-road mobile VOC and NOx emissions, together with daily vehicle miles traveled (DVMT).

The VOC emissions decreased by 28% despite an increase of 11% in DVMT. This is a reflection of the effective on-road mobile source control programs that were instituted during the period.

NOx emissions increased by 22%, because the on-road mobile source controls had been targeted toward VOC reduction. NOx controls for mobile sources have been put in place more recently, and their effect will be reflected as the vehicle fleet turns over.

On-Road Mobile Emissions and DVMT

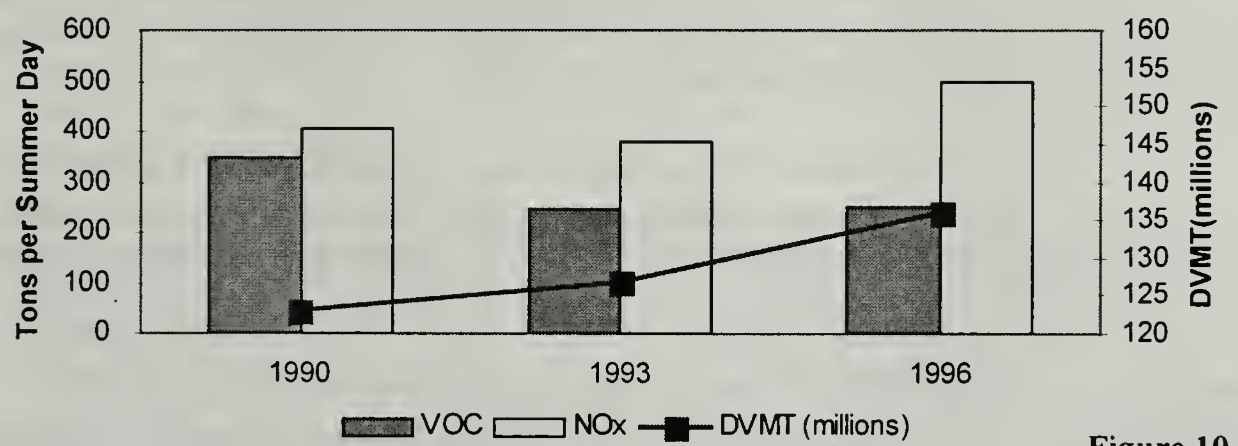


Figure 10

DVMT = daily vehicle miles traveled

Section I

Ambient Air Monitoring Program

Program Overview

Introduction

Regulations set forth in the Code of Federal Regulations (Title 40, Part 58) require each state to establish an air monitoring network. A network of National Air Monitoring Stations (NAMS) located in urban areas and based on population provides a consistent nationwide database. The State and Local Air Monitoring Stations (SLAMS), supplementing the NAMS sites, allows a more comprehensive assessment of air quality.

The Air Assessment Branch (AAB) of the Department of Environmental Protection (MADEP) collects ambient air quality data from sites throughout Massachusetts. During 1998, AAB operated a public monitoring network of 42 stations located in 27 cities and towns. AAB also oversaw an industrial network of six stations located in two cities and one town.

MADEP submits the ambient air quality data into the Aerometric Information Retrieval System (AIRS), a computer-based repository of national air quality information administered by the U.S. Environmental Protection Agency (USEPA).

Why is air quality data collected?

The ambient air quality data is used for the following purposes:

- to verify compliance with national ambient air quality standards
- to support development of regulations designed to reduce ambient air pollution
- to assess the effectiveness of existing air pollution control strategies
- to provide aerometric data for long-term trend analysis and special research, and
- to fulfill USEPA reporting requirements for ambient air quality data.

What is monitored?

The parameters monitored by the Air Assessment Branch fall into the following categories:

- **Criteria pollutants** - have National Ambient Air Quality Standards (NAAQS). The seven criteria pollutants are:
  - sulfur dioxide (SO_2)
  - ozone (O_3)
  - carbon monoxide (CO)
  - nitrogen dioxide (NO_2)
  - lead (Pb)
  - particulate matter 10 microns (PM_{10})
  - particulate matter 2.5 microns ($PM_{2.5}$)

Continued on next page

What is monitored?, Continued

Non-criteria pollutants - do not have national standards established. These pollutants are:

- nitrogen oxide (NO) • total nitrogen oxides (NOx)
- total reactive oxidized nitrogen (NOy) • total suspended particulates (TSP)
- Photochemical Assessment Monitoring Stations (PAMS) – these measurements are of ozone precursor and reaction product chemicals including volatile organic compounds (VOC).

- **Meteorological parameters** monitored are:
  - wind speed/wind direction (WS/WD) • relative humidity (RH)
  - temperature (TEMP) • barometric pressure (BP) • solar radiation

For further information

For further information pertaining to this report, contact the Air Assessment Branch. For information about other air quality matters, please contact MADEP's Division of Planning and Evaluation in Boston, or a MADEP regional office. The addresses are listed below. Maps showing the cities and towns covered by each regional office are on the following pages.

DEP – WERO (WESTERN) 436 Dwight Street Springfield, MA 01103 (413) 784-1100 Mary Holland: Regional Director	**DEP - CERO (CENTRAL)** 627 Main Street Worcester, MA 01608 (508) 792-7650 Robert Golledge: Regional Director
DEP - NERO (NORTHEAST/MET-BOSTON) 205A Lowell Street Wilmington, MA 01887 (978) 661-7600 William Gaughan: Regional Director	**DEP - SERO (SOUTHEAST)** 20 Riverside Drive Lakeville, MA 02347 (508) 946-2700 Paul Taurasi: Regional Director
BUREAU OF WASTE PREVENTION One Winter Street Boston, MA 02108 (617) 292-5593 Barbara Kwetz: Director	**AIR ASSESSMENT BRANCH** William X. Wall Experiment Station 37 Shattuck Street Lawrence, MA 01843 (978) 975-1138 Donald Steele: Branch Chief

Information about MADEP's various programs are available on the internet from MADEP's website (www.state.ma.us/dep/). The USEPA maintains a website (www.epa.gov/airsdata/) which has air quality information from all the states.

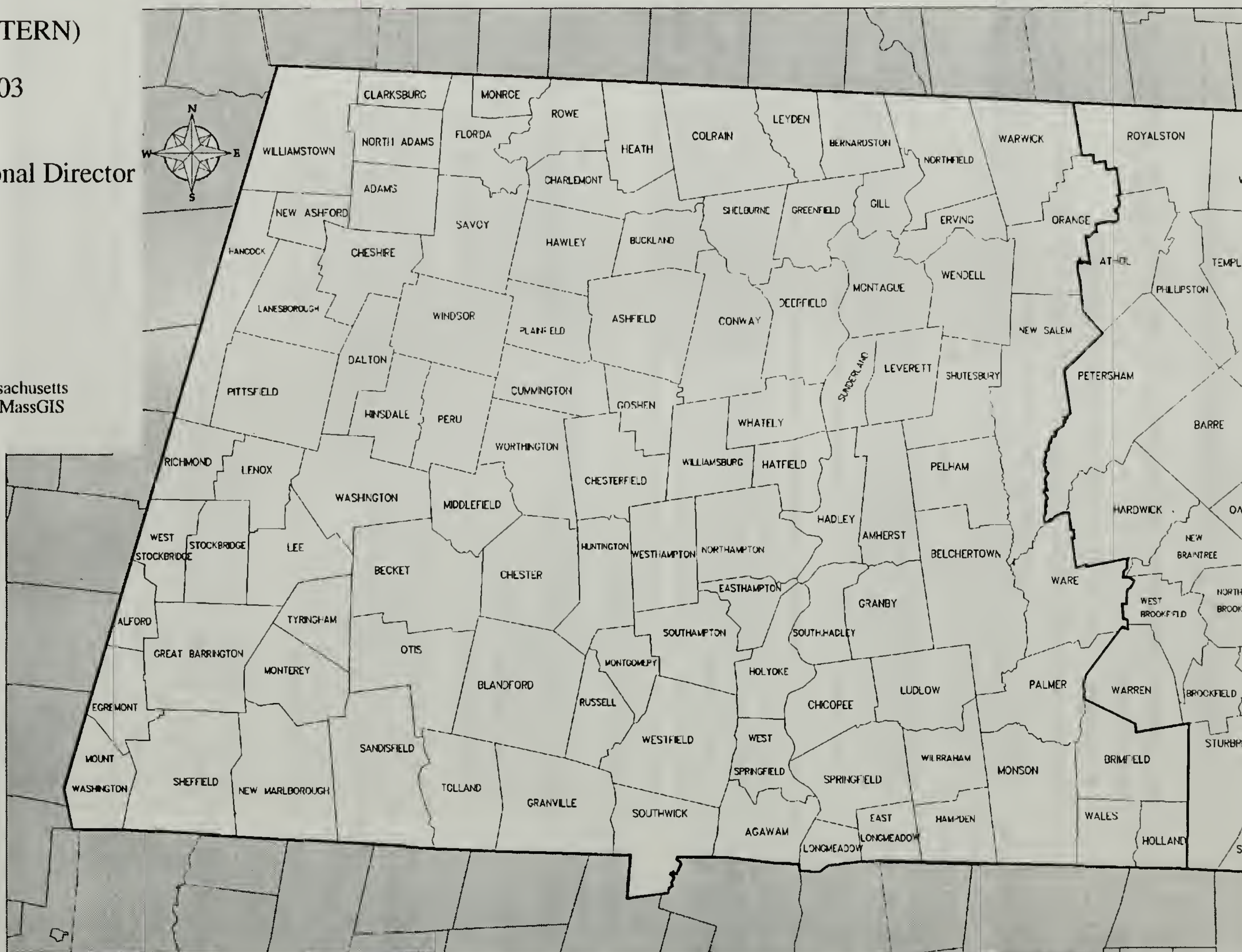
DEP's Western Region and neighboring communities

DEP –WERO (WESTERN)
436 Dwight St.
Springfield, MA 01103
(413)784-1100

Mary Holland: Regional Director

DATA SOURCES:

Community Boundaries of Massachusetts and neighboring states –EOEA/MassGIS



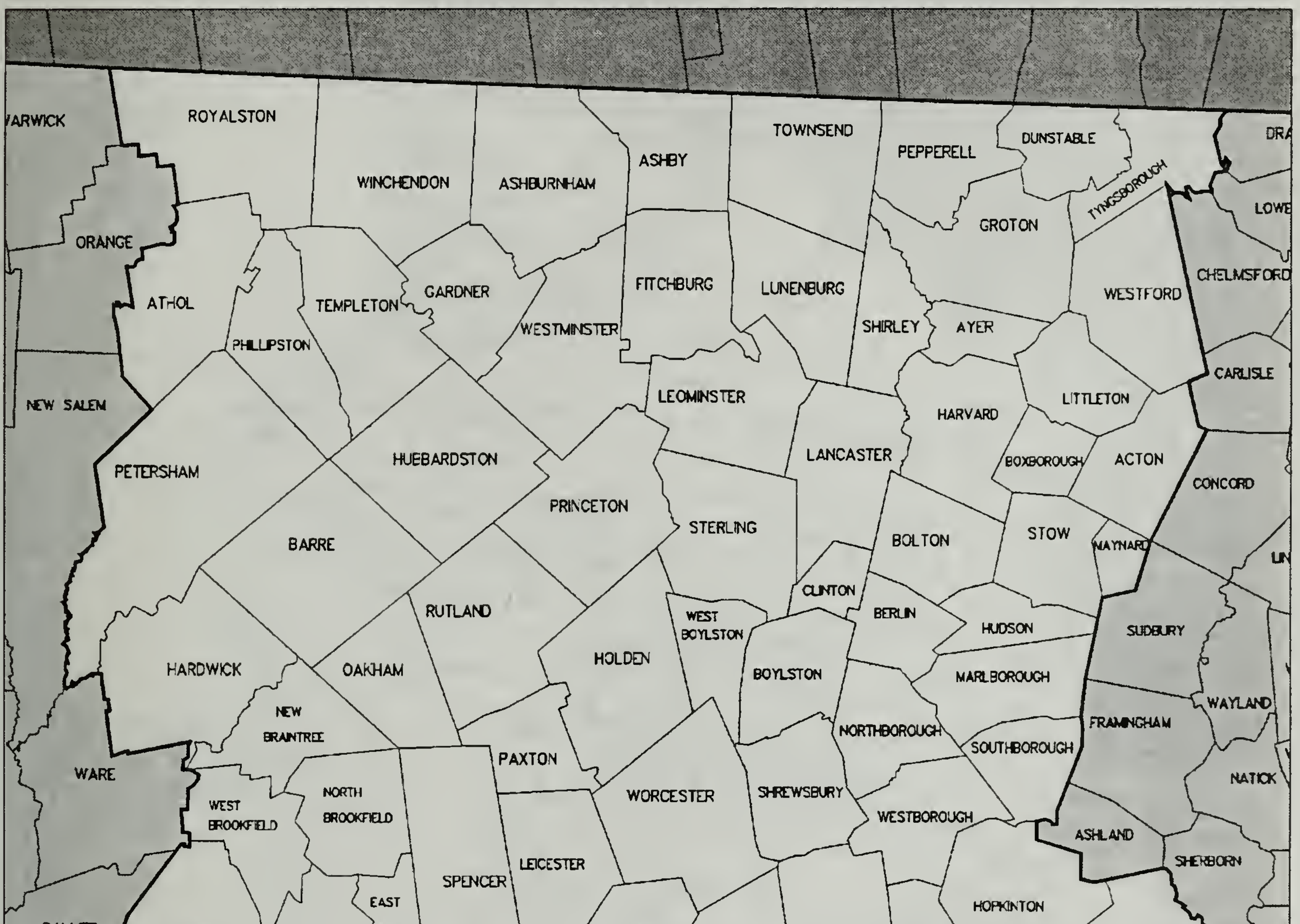
/dep/projects/daqc1/monmaps/at-regions.aml

DEP's Central Region and neighboring communities

DEP –CERO (CENTRAL)
627 Main St.
Worcester, MA 01608
(508)792–7650

Robert Golledge: Regional Director

DATA SOURCES:
Community Boundaries of Massachusetts and neighboring states –EOEA/MassGIS

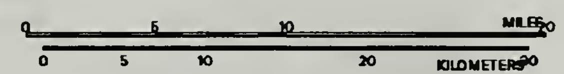


/dep/projects/daqc1/monmaps/at-regions.aml

DEP's Northeast Region and neighboring communities

DEP –NERO (NORTHEAST/MET-BOSTON)
205A Lowell St.
Wilmington, MA 01887
(978)661-7600

William Gaughan: Regional Director



DATA SOURCES:
Community Boundaries of Massachusetts and neighboring states –EOEA/MassGIS

/dep/projects/daqc1/monmaps/at-regions.aml

DEP's Southeast Region and neighboring communities

DEP –SERO (SOUTHEAST)
20 Riverside Drive
Lakeville, MA 02347
(508)946-2700

Paul Taurasi: Regional Director

DATA SOURCES:

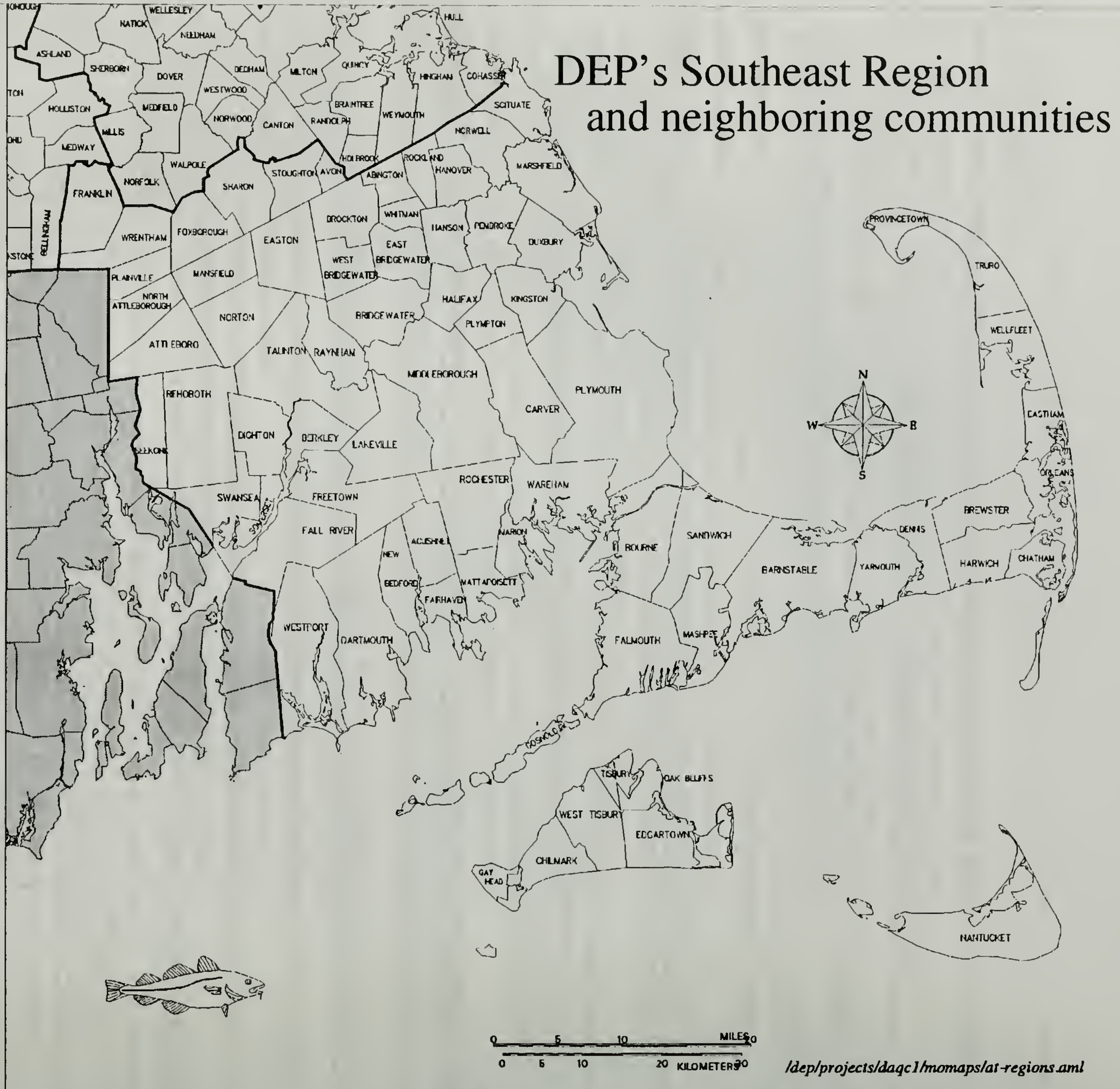
Community Boundaries of Massachusetts and neighboring states –EOEA/MassGIS

DEP BWP – Bureau of Waste Prevention

MASSGIS

EXECUTIVE OFFICE of ENVIRONMENTAL AFFAIRS

DEP Department of Environmental Protection



/dep/projects/daqc1/momaps/at-regions.aml

National Ambient Air Quality Standards

- **Primary Standards** – designed to protect public health against adverse health effects with a margin of safety.
- **Secondary Standards** - designed to protect against damage to crops, vegetation, and buildings from air pollution.

POLLUTANT	AVERAGING TIME*	PRIMARY	SECONDARY
SO2	Annual Arithmetic Mean	0.03 ppm (80 ug/m^3)	None
	24-Hour	0.14 ppm (365 ug/m^3)	None
	3-Hour	None	0.50 ppm (1300 ug/m^3)
CO	8-Hour	9 ppm (10 mg/m^3)	Same as Primary Standard
	1-Hour	35 ppm (40 mg/m^3)	Same as Primary Standard
O3	1-Hour	0.12 ppm (235 ug/m^3)	Same as Primary Standard
	8-Hour	0.08 ppm (157 ug/m^3)	Same as Primary Standard
• The 1-hour standard: • applies only to areas with continued violations of the 1-hour standard. In Massachusetts, it applies to the western region of the state, in Berkshire, Hampshire, Hampden and Franklin counties. • is met when the expected exceedance days (the daily maximum 1-hour concentration exceeds 0.12 ppm) do not exceed one per year (3-year average). • The 8-hour standard is met when the 3-year average of the 4th-highest daily maximum 8-hour average does not exceed 0.08 ppm.			
Pb	Calendar Quarter Arithmetic Mean	1.5 ug/m^3	Same as Primary Standard
NO2	Annual Arithmetic Mean	0.053 ppm 100 ug/m^3	Same as Primary Standard
PM2.5 Particulates up to 2.5 microns in size	Annual Arithmetic Mean	15 ug/m^3	Same as Primary Standard
	24-Hour	65 ug/m^3	Same as Primary Standard
• The annual standard is met when the annual average of the quarterly mean PM2.5 concentrations is less than or equal to 15 ug/m^3 (3-year average). If spatial averaging is used, the annual average from all monitors within the area may be averaged in the calculation of the 3-year mean. • The 24-hour standard is met when 98th percentile value is less than or equal to 65 ug/m^3 (3-year average).			
PM10 Particulates up to 10 microns in size	Annual Arithmetic Mean	50 ug/m^3	Same as Primary Standard
	24-Hour	150 ug/m^3	Same as Primary Standard
• The PM10 standard is based upon estimated exceedance calculations described in 40CFR Part 50, Appendix K. • The annual standard is met if the estimated annual arithmetic mean does not exceed 50 ug/m3. • The 24-hour standard is attained if the estimated number of days per calendar year above 150 ug/m3 does not exceed one per year.			

μg/m^3 = micrograms per cubic meter **ppm** = parts per million **mg/m^3** = milligrams per cubic meter

* Standards based upon averaging times other than the annual arithmetic mean must not be exceeded more than once a year.

Pollutant Health Effects and Sources

Ozone (O_3)	• Ground level and stratospheric O3 are often confused. Ground level O3 is a health and environmental problem, whereas stratospheric O3 is beneficial because it filters out the sun's harmful ultraviolet radiation. • High levels irritate mucous membranes. This causes reduced lung function, nasal congestion, eye and throat irritation, and reduced resistance to infection. • Toxic to vegetation, inhibiting growth and causing leaf damage. • Weakens materials such as rubber and fabrics. • Highest levels occur during the summer, and are a product of the reaction of nitrogen oxides and hydrocarbons in the presence of strong sunlight and high temperatures. • Sources of nitrogen oxides and hydrocarbons, the O3 precursors, include motor vehicles and power plants.
Carbon Monoxide (CO)	• Reacts in the bloodstream with hemoglobin reducing oxygen carried to organs and tissues. • Health threat most severe for those with cardiovascular disease. • Symptoms include shortness of breath, chest pain, headaches, confusion, and loss of coordination. • High levels are possible near parking lots and city streets with slow-moving cars. • Motor vehicles are the largest source of CO, which is produced from incomplete combustion of carbon in fuels.

Sulfur Dioxide (SO2)	• Combines with water vapor to form acidic aerosols harmful to the respiratory tract, aggravating symptoms associated with lung diseases such as asthma and bronchitis.
	• SO2 is a primary contributor to acid deposition. Impacts of acid deposition include:
	  • acidification of lakes and streams • damage to vegetation
	  • damage to materials • degradation of visibility
	• SO2 is a product of fuel combustion (e.g., burning coal and oil). Sources include heat and power generation facilities, and petroleum refineries.

Nitrogen Dioxide (NO2)	• Lowers resistance to respiratory infections and aggravates symptoms associated with asthma and bronchitis. • NO2 contributes to acid deposition. [See SO2 listing above for the effects.] • NO2 and NO contribute to the formation of ozone. • NO2 is formed from the oxidation of nitric oxide (NO). Major sources of NO are fuel combustion, heating and power plants, and motor vehicles.

Continued on next page

Particulate Matter (PM10 & PM2.5)	• Particulate matter is tiny airborne particles or aerosols, which include dust, dirt, smoke, and liquid droplets. • The numbers, 2.5 and 10, refer to the particle size, measured in microns, which are collected by the monitors. • The small size of the particulates allows entry into the respiratory system. Long term exposure allows the particulates to accumulate in the lungs and affects breathing and respiratory symptoms. • Particulate matter causes soiling and corrosion to materials. • Particulate matter contributes to atmospheric haze that degrades visibility. • Sources include industrial process emissions, motor vehicles, incinerators, heat and power plants, and motor vehicles.
Lead (Pb)	• Exposure to lead may occur by inhalation or ingestion of food, water, soil or dust particles. • Children and fetuses are more susceptible to the effects of lead exposure. • Lead causes mental retardation, brain damage, and liver disease. It may be a factor in high blood pressure and damages the nervous system. • The primary source for airborne lead used to be motor vehicles, but the use of unleaded gasoline has greatly reduced those emissions. Other sources are lead smelters and battery plants.

Public and Industrial Network Descriptions

1998 Public Monitoring Network

The Air Assessment Branch operates a public ambient air monitoring network.

Network size

- 42 - monitoring stations
- 27 - cities & towns with monitoring stations

Number of continuous monitors

Continuous monitors measure the air quality 24 hours a day. The data is averaged to provide 1-hour averages.

- Criteria pollutant monitors – these pollutants have National Ambient Air Quality Standards (NAAQS)
  - 9 – CO (carbon monoxide)
  - 12 – NO_2 (nitrogen dioxide). NO (nitrogen oxide) and NO_x (total nitrogen oxides) are also measured by these monitors
  - 16 – O_3 (ozone)
  - 10 – SO_2 (sulfur dioxide)

- Meteorological monitors
  - 7 – BP (barometric pressure)
  - 7 – RH (relative humidity)
  - 6 - SOLAR RAD (solar radiation)
  - 11 – TEMP (temperature)
  - 11 – WS/WD (wind speed/wind direction)
  - 1 – Upper Meteorology – this monitor measures WS/WD and TEMP at various altitudes. This aids in the analysis of pollutant transport.

- Other Monitors
  - 2 – NO_y (Total Reactive Oxidized Nitrogen)
  - 7 - PAMS (Photochemical Assessment Monitoring Station). These monitors measure VOC (volatile organic compounds).

Number of intermittent monitors

Intermittent monitors take discrete samples for a specific time period. The samples are taken everyday, every third day, or every sixth day. The data is averaged in 3-hour or 24-hour intervals.

- Criteria pollutant monitors – these pollutants have National Ambient Air Quality Standards (NAAQS)
  - 1 – Pb (Lead)
  - 16 - PM10 – (particulate matter – 10 microns)
  - 18 – PM2.5 – (particulate matter – 2.5 microns)

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1998 Public Monitoring Network, continued

Number of intermittent monitors, Continued

- Other Monitors
  - 1 - Acid Deposition. Precipitation is collected and analyzed for acidic compounds that are harmful to the environment. This monitor, located in Waltham, is part of the National Atmospheric Deposition Program (NADP). Two other monitors in Massachusetts not operated by MADEP, in Truro and Ware, are also part of the NADP.
  - 7 - PAMS (photochemical assessment monitoring station). These monitors measure VOC (volatile organic compounds).
  - 5 – TSP (total suspended particulates)

1998 Industrial Monitoring Network

Industries monitor air quality and submit data under agreement with MADEP. The data must be collected using quality assurance requirements established by MADEP and USEPA.

Network size

- 6 - monitoring stations
- 3 - cities and towns with monitoring stations

Number of continuous monitors

Continuous monitors measure the air quality 24 hours a day. The data is averaged to provide 1-hour averages.

- Criteria pollutant monitors – these pollutants have National Ambient Air Quality Standards (NAAQS)
  - 1 – NO_2 (nitrogen dioxide). NO (nitrogen oxide) and NO_x (total nitrogen oxides) are also measured by this monitor
  - 6 – SO_2 (sulfur dioxide)

- Meteorological monitors
  - 6 – WS/WD (wind speed/wind direction)

Number of intermittent monitors

Intermittent monitors take discrete samples for a specific time period. These monitors sample every sixth day, and the data is averaged for a 24-hour interval.

- Other Monitors
  - 4 – TSP (total suspended particulates)
  - 4 – SO_4 (sulfate)

Public Site Directory

CITY SITE LOCATION	DATE SAMPLING BEGAN	AIRS CODE	PARAMETERS MONITORED
ADAMS Mt. Greylock Summit	05/01/89	25-003-4002	O3
AGAWAM 152 Westfield St.	01/01/82	25-013-0003	PAMS;O3;NO2;NO;NOX;TEMP; WS/WD; SOLAR RAD;RH;BP
AMHERST N. Pleasant St.	04/01/88	25-015-0103	O3
BOSTON Kenmore Square 590 Commonwealth Ave.	01/01/65	25-025-0002	SO2;NO2;NO;NOX;CO;TEMP; PM10;TSP:Pb; PM2.5(started 12/1/98)
BOSTON Fire Headquarters Southampton St.	07/01/70	25-025-0012	PM10
BOSTON Sumner Tunnel Visconti St. East Boston	01/01/74	25-025-0016	CO
BOSTON 340 Breman St. East Boston	01/01/79	25-025-0021	SO2;NO2;NO;NOX;CO;PM10
BOSTON Fire Station 200 Columbus Ave.	01/01/81	25-025-0024	PM10
BOSTON 1 City Square Charlestown	01/01/85	25-025-0027	PM10 TSP (ended 12/31/98) PM2.5(started 12/1/98)
BOSTON Post Office Square	12/29/89	25-025-0038	CO
BOSTON Harrison Ave. Roxbury	12/01/98	25-025-0042	PM2.5(started 12/1/98)
BROCKTON 120 Commercial St	12/01/98	25-023-0004	PM2.5(started 12/1/98)
CHELSEA Soldier's Home Powder Horn Hill	01/01/84	25-025-1003	O3;SO2;NO2;NO;NOX
CHICOPEE Westover Air Force Base	01/01/83	25-013-0008	PAMS;O3;NO2;NO;NOX;TEMP; WS/WD; SOLAR RAD;RH;BP; PM2.5(started 12/1/98)
EASTON Borderland State Park	07/01/95	25-005-1005	PAMS;O3;WS/WD;TEMP; SOLAR RAD;RH;BP
FAIRHAVEN Wood School Scontuit Rd.	01/01/82	25-005-1002	O3;WS/WD

Continued on next page

CITY SITE LOCATION	DATE SAMPLING BEGAN	AIRS CODE	PARAMETERS MONITORED
FALL RIVER Fire Headquarters 165 Bedford St.	01/01/58	25-003-3001	PM10(shutdown 12/31/98) PM2.5(started 12/1/98)
FALL RIVER Fire Station Globe St.	02/01/75	25-005-1004	SO2
FITCHBURG Fitchburg State College 67 Rindge St.	12/01/98	25-027-2004	PM2.5(started 12/1/98)
HAVERHILL Consentino School Washington St.	07/19/94	25-009-5005	TSP(shutdown 12/31/98) PM2.5(started 12/1/98)
LAWRENCE Storrow Park High St.	01/01/80	25-009-0005	O3;SO2;WS/WD; PM10(shutdown 12/31/98) PM2.5(started 12/1/98)
LOWELL Old City Hall Merrimack St.	07/17/81	25-017-0007	CO
LYNN Lynn Water Treatment Plant 390 Parkland St.	01/01/92	25-009-2006	PAMS;O3;NO2;NO;NOX;WS/WD; TEMP;SOLAR RAD;RH;BP; TSP(shutdown 12/31/98) PM2.5(started 12/1/98)
NEW BEDFORD YMCA 25 Water St.	01/01/84	25-005-2004	PM10(shutdown 12/31/98) PM2.5(started 12/1/98)
NEWBURY US Department of the Interior Sunset Boulevard	08/01/84	25-009-4004	PAMS;O3;NO2;NO;NOX;WS/WD; TEMP;SOLAR RAD;RH;BP; TSP(shutdown 12/31/98)
PITTSFIELD Silvio Conte Federal Building 78 Center St.	12/01/98	25-003-5001	PM2.5(started 12/1/98)
QUINCY Fire Station Hancock St.	01/01/76	25-021-0007	PM10(shutdown 12/31/98) PM2.5(started 12/1/98)
SPRINGFIELD Howard School 59 Howard Street	01/01/78	25-013-0011	PM10;TSP
SPRINGFIELD Liberty St.	04/01/88	25-013-0016	SO2;NO2;NO;NOX;CO;WS/WD; TEMP;PM2.5(started 12/1/98)
SPRINGFIELD Longhill St.	01/01/78	25-013-1009	SO2

Continued on next page

Public Site Directory, Continued

CITY SITE LOCATION	DATE SAMPLING BEGAN	AIRS CODE	PARAMETERS MONITORED
SPRINGFIELD 1586 Columbus Ave.	11/01/81	25-013-2007	CO;PM10;TSP(shutdown 3/1/98); PM2.5(started 12/1/98)
STOW U.S. Military Reservation	04/01/98	25-017-1102	O3;Upper Meteorology; PM2.5(started 12/1/98)
SUDBURY Nat. Wildlife Refuge Water Row Rd.	06/01/80	25-017-1801	O3;PM10
TRURO Cape Cod National Park Fox Bottom Area	04/01/87	25-001-0002	PAMS;O3;NO2;NO;NOX; WS/WD;TEMP;BP;RH; SOLAR RAD
WALTHAM U. Mass Field Station Beaver St.	01/01/71	25-017-4003	O3;SO2;WS/WD;TEMP;Acid Deposition
WARE Quabbin Summit	06/01/80	25-015-4002	PAMS;O3;SO2;NO2;NO;NOX;NOy; PM10;WS/WD;TEMP;BP;RH; SOLAR RAD; PM2.5(started 12/1/98)
WEST SPRINGFIELD Fire Station Van Deene St.	04/01/87	25-013-5003	PM10(shutdown 12/31/98);
WORCESTER U. Mass Medical Center 419 Belmont St.	01/01/78	25-027-0013	PM10
WORCESTER Worcester Airport	05/07/79	25-027-0015	O3;WS/WD;TEMP
WORCESTER YWCA 2 Washington St.	01/01/78	25-027-0016	PM10
WORCESTER Fire Station Central St.	01/01/82	25-027-0020	SO2;NO2;NO;NOX;CO; PM2.5(started 12/1/98)
WORCESTER Grafton and Franklin Sts.	07/28/92	25-027-0022	CO

Industrial Site Directory

REPORTING ORGANIZATION CITY SITE LOCATION	DATE SAMPLING BEGAN	AIRS CODE	PARAMETERS MONITORED
ATLANTIC GELATIN Stoneham (Hill St.) Hill Street	01/01/78	25-017-1701	SO2;WS/WD
BOSTON EDISON Boston Long Island	01/01/78	25-025-0019	SO2;WS/WD;TSP;SO4
BOSTON EDISON Dorchester Dewar Street	01/01/78	25-025-0020	SO2;WS/WD;TSP;SO4
BOSTON EDISON East Boston Breman Street	01/01/79	25-025-002[illegible]	SO2;WS/WD;TSP;SO4
BOSTON EDISON South Boston East First Street	01/01/93	25-025-0040	SO2;NO2;NO;NOX;WS/WD;TSP;SO4
HAVERHILL PAPERBOARD Haverhill Nettle School	09/10/85	25-009-5004	SO2;WS/WD

Air Quality Related Websites

Websites of interest

The table below has a listing of internet websites that have air quality data or related information.

Web Address	Organization	Description
http://www.state.ma.us/dep/	MADEP	Homepage for Massachusetts DEP. Links to MADEP programs, regions and publications. Links to the Daily Ozone Forecast during ozone season (May1 through September 30).
http://www.state.ma.us/dep/bwp/daqc/	MADEP	Homepage for the MADEP Air Program Planning Unit.
http://www.epa.gov/airnow/ozone.html	USEPA	Ozone Mapping Project – color-coded animated maps using near real-time data that show how ozone is formed and transported downwind.
http://www.epa.gov/region01/eco/dailyozone/ozone.html	USEPA	Ozone maps of the Northeast U.S. using near real-time data.
http://www.epa.gov/airsdata/	USEPA	Access to air pollution data for the entire U.S.
http://www.epa.gov/ceis/	USEPA	Center for Environmental Information and Statistics – a single convenient source for information on environmental quality.
http://www.nescaum.org/	NESCAUM	Northeast States for Coordinated Air Use Management – an interstate association of air quality control divisions from the six New England states, New York and New Jersey.
http://www.hazecam.net/	NESCAUM (CAMNET)	Real-time Air Pollution Visibility Camera Network-- live pictures and air quality conditions for urban and rural vistas across the Northeast U.S.
http://www.4cleanair.org/links.html	STAPPA/ALAPCO	State and Territorial Air Pollution Program Administrators/Association of Local Air Pollution Control Officials – site has links to air quality related agencies and organizations.
http://nadp.sws.uiuc.edu/	NADP	National Atmospheric Deposition Program – maps and data from the nationwide precipitation monitoring network. Site also has data from the Mercury Deposition Network.
http://www.roxburyair.com/ (under development)	EMPACT	Environmental Monitoring for Public Access and Community Tracking – real time data from the MADEP Roxbury air monitoring site will be available.

Section II

Attainment and Exceedances of Air Quality Standards

Attainment Status Summary

What determines attainment status?

The National Ambient Air Quality Standards (NAAQS) set the concentration limits that determine the attainment status for each criteria pollutant. The NAAQS are listed on page 14. Massachusetts does not attain the public health standard for two pollutants – ozone (O3) and carbon monoxide (CO).

O3 attainment status

There are two O3 standards based on different averaging times, 1-hour and 8-hours. The 8-hour standard, which became effective in 1997, provides increased health protection against longer exposures to O3.

The 1-hour standard was revoked for portions of Massachusetts in a ruling published by the USEPA on June 9, 1999. These areas had no violations of the 1-hour standard during the period 1996–1998. The standard is in effect in the western region of Massachusetts covering Berkshire, Franklin, Hampden, and Hampshire counties.

The 8-hour standard is based on a 3-year averaging period. In the year 2000, the USEPA plans to formally determine which areas of the country do not meet the 8-hour standard using data from 1997–1999 and designate them "non-attainment."

The 8-hour standard is expected to apply to the entire state, including the areas where the 1-hour standard has been revoked. Areas where the 1-hour standard has been revoked and have yet to be classified for the 8-hour standard must continue to implement the programs that are required by the O3 State Implementation Plan.

CO attainment status

Massachusetts has made significant progress in attaining the CO standard by implementing air pollution control programs. The last violation of the CO NAAQS occurred in Boston in 1986. The Boston metropolitan area was redesignated to attainment of the CO federal air quality standard by the USEPA in 1996.

Lowell, Springfield, Waltham, and Worcester remain in non-attainment of the CO standard. MADEP is currently preparing a request to the USEPA to redesignate these areas to attainment for CO because monitoring data has been below the standard for many years. The redesignation request, which includes technical support and a maintenance plan, will be subject to public review and comment prior to being submitted to the USEPA.

Ozone Exceedances

What determines an exceedance?

An O3 exceedance occurs when a daily O3 value exceeds the concentration of the National Ambient Air Quality Standards (NAAQS). There are two O3 standards based on different averaging times, 1-hour and 8-hours. An exceedance of the 1-hour standard is an hourly value during a day that is equal to or greater than 0.125 ppm. An exceedance of the 8-hour standard is an 8-hour averaged value during a day that is equal to or greater than 0.085 ppm.

The difference between an exceedance and a violation

Recording an exceedance of the O3 standards does not necessarily mean that a violation of the standard has occurred. Violations of the 1-hour and 8-hour standards are based upon 3-year averages of O3 data as explained below.

Violations of the 1-hour standard are determined using the number of expected exceedance days – days with a 1-hour value that exceeds the standard of 0.12 ppm. (Expected exceedance days are used to account for missing data.) A violation of the 1-hour standard requires a 3-year average that is greater than one expected exceedance day. In other words, if there are 4 or more days during a 3-year period with O3 1-hour values that are equal to or greater than 0.125 ppm, a violation of the 1-hour standard has occurred.

Violations of the 8-hour standard are determined using the annual 4th-highest daily maximum 8-hour O3 value. A violation requires a 3-year average of the annual 4th-highest daily maximum 8-hour value that is equal to or greater than 0.085 ppm. In other words, the highest 8-hour value for each day during a year is ranked from highest to lowest. Then, the 4th-highest value for 3 consecutive years is averaged. If the 3-year average is 0.085 ppm or greater a violation of the 8-hour standard has occurred.

O3 exceedances and violations during 1998

During 1998, there were 2 exceedance days and a total of 3 exceedances of the 1-hour standard. There were 12 exceedance days and 65 exceedances of the 8-hour standard. An exceedance day is a day during which an exceedance occurred. A monitoring site only records one exceedance per day – the exceedance with the highest value.

Using data from 1996–1998, only one out of sixteen sites violated the 1-hour standard. USEPA will determine 8-hour violations from data collected during 1997–1999. If 8-hour violations were based upon the period 1996–1998, ten of the fifteen sites (those with 3 years of data) would have been in violation of the 8-hour standard.

Continued on next page

1998 O3 Exceedances (ppm)

Date	Site	8-hour exceed	1-hour exceed
5/28	Fairhaven	0.087	
	Newbury	0.087	
	Truro	0.086	
5/29	Chelsea	0.088	
	Chicopee	0.087	
	Easton	0.088	
	Lynn	0.103	
	Newbury	0.103	
	Stow	0.109	
	Sudbury	0.091	
	Waltham	0.098	
	Ware	0.110	0.128
	Worcester	0.103	
7/14	Amherst	0.100	
	Chelsea	0.088	
	Chicopee	0.102	
	Easton	0.086	
	Lynn	0.100	
	Newbury	0.089	
	Stow	0.090	
	Sudbury	0.086	
	Waltham	0.099	
	Ware	0.101	
	Worcester	0.097	
7/15	Chelsea	0.087	
	Chicopee	0.097	
	Easton	0.091	
	Lynn	0.105	
	Newbury	0.089	
	Stow	0.090	
	Sudbury	0.085	
	Waltham	0.100	
	Worcester	0.109	
7/16	Amherst	0.096	
	Chicopee	0.104	
	Lynn	0.090	
	Newbury	0.096	
	Stow	0.089	
	Waltham	0.090	
	Ware	0.102	
	Worcester	0.087	
7/17	Ware	0.088	
7/28	Ware	0.085	
	Worcester	0.086	
8/5	Easton	0.086	
	Lynn	0.088	
	Newbury	0.096	
8/16	Waltham	0.085	
8/24	Agawam	0.093	
	Chelsea	0.095	
	Chicopee	0.093	
	Easton	0.105	
	Lawrence	0.088	
	Lynn	0.108	
	Stow	0.098	
	Sudbury	0.104	
	Waltham	0.116	0.134
	Ware	0.093	
	Worcester	0.123	0.139
9/6	Easton	0.090	
	Fairhaven	0.099	
	Lynn	0.087	
	Truro	0.110	
	Waltham	0.087	
9/27	Easton	0.088	

Continued on next page

Exceedance days and total exceedance trends

The following figures show the recent trends of exceedance days and the total number of exceedances of the 1-hour and 8-hour O3 standards. An exceedance day is a day on which an exceedance of the standard has occurred.

The trend for the 1-hour data in Figure 11 shows a decline in the number of exceedances and exceedance days over the last ten years. The trend in Figure 12 shows that, under the new 8-hour standard, there are a greater number of exceedances and exceedance days compared to the 1-hour standard.

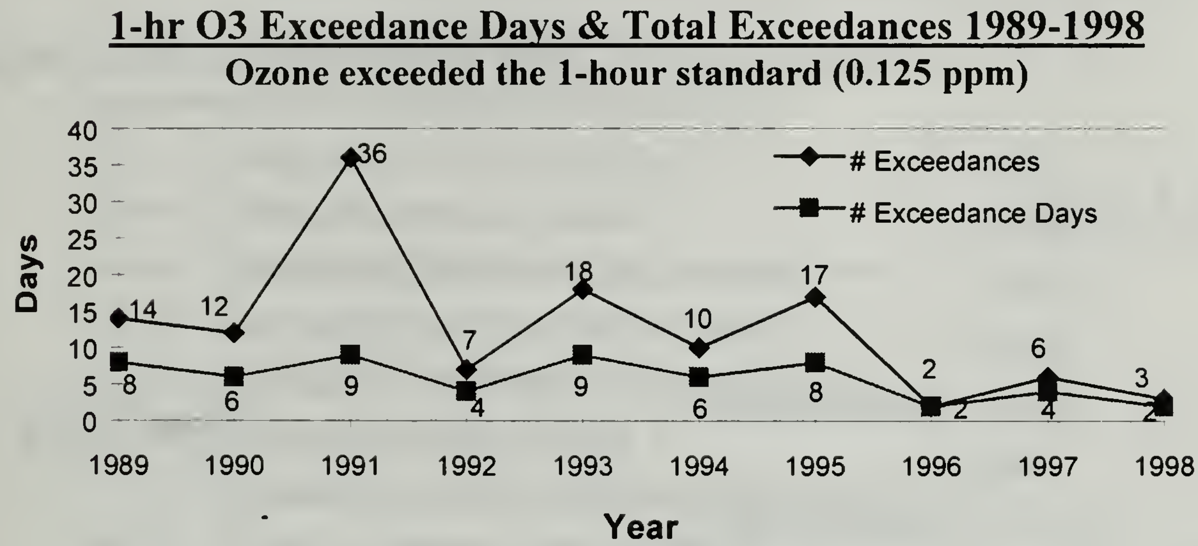

Figure 11

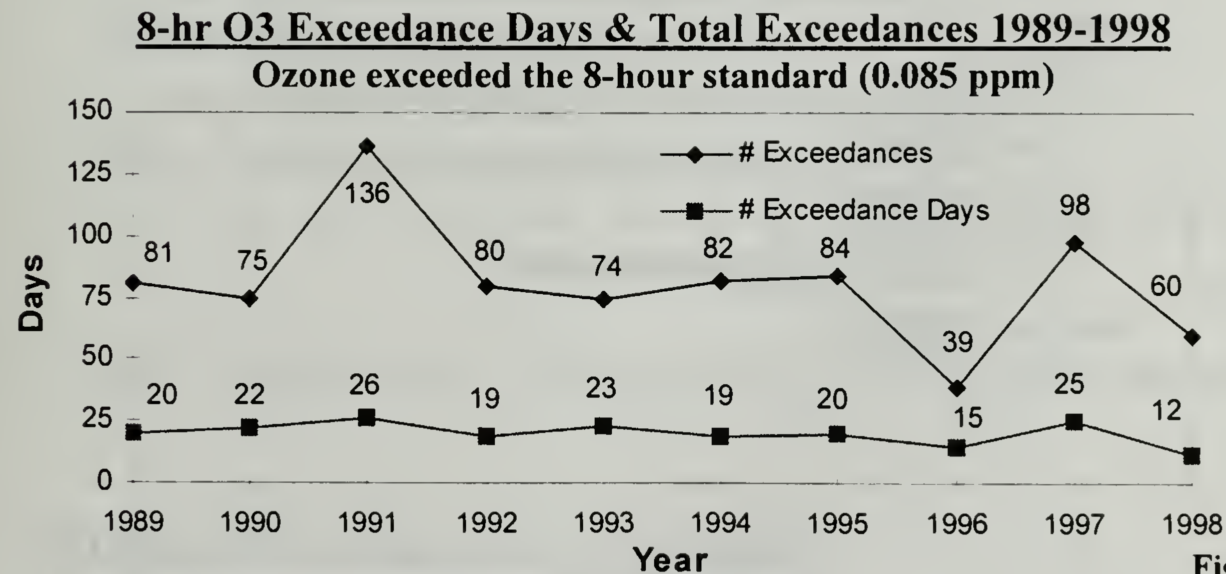

Figure 12

1998 total exceedances does not include Stow, a new site that year.

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1-hour O3 violations

A violation of the 1-hour standard requires a 3-year average greater than one for the number of expected exceedance days (the daily maximum O3 value exceeds 0.12 ppm). In June 1999, the USEPA revoked the 1-hour standard in parts of Massachusetts. Massachusetts remains in non-attainment of the O3 standard in the western region of the state, including Berkshire, Franklin, Hampden, and Hampshire counties.

Figure 13 shows the 3-year average of expected 1-hour exceedances at the Massachusetts' sites for the period 1996–1998. Only the site located in Ware was in violation of the 1-hour standard during this period. Figure 14 shows the decrease in the number of 1-hour violation sites in Massachusetts during the last 10 years.

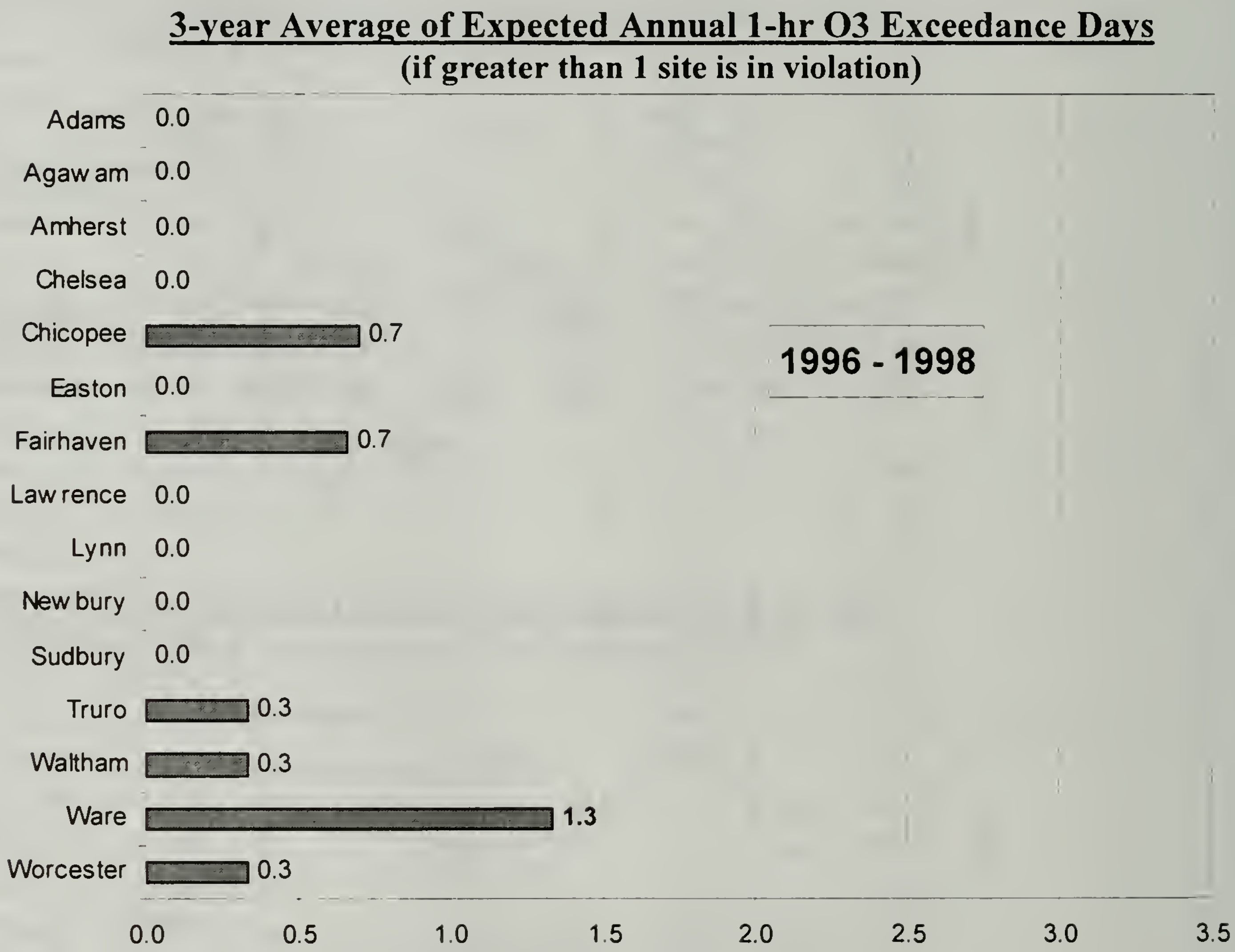

Figure 13

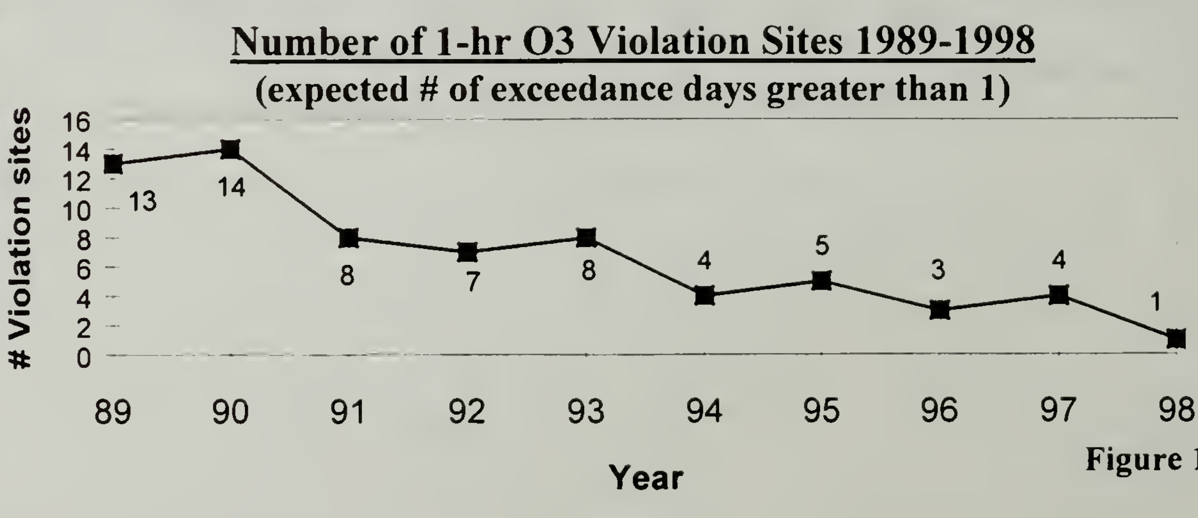

Figure 14

8-hour O3 violations

A violation of the 8-hour standard requires a 3-year average of the annual 4th-highest daily maximum 8-hour value that is equal to or greater than 0.085 ppm. The 8-hour attainment designations will be determined from data collected during 1997–1999.

If 8-hour violations were based upon the period 1996–1998, ten of the fifteen sites with 3 years of data would have been in violation of the 8-hour standard. Figure 15 shows the 8-hour violation status for the 1996–1998 period.

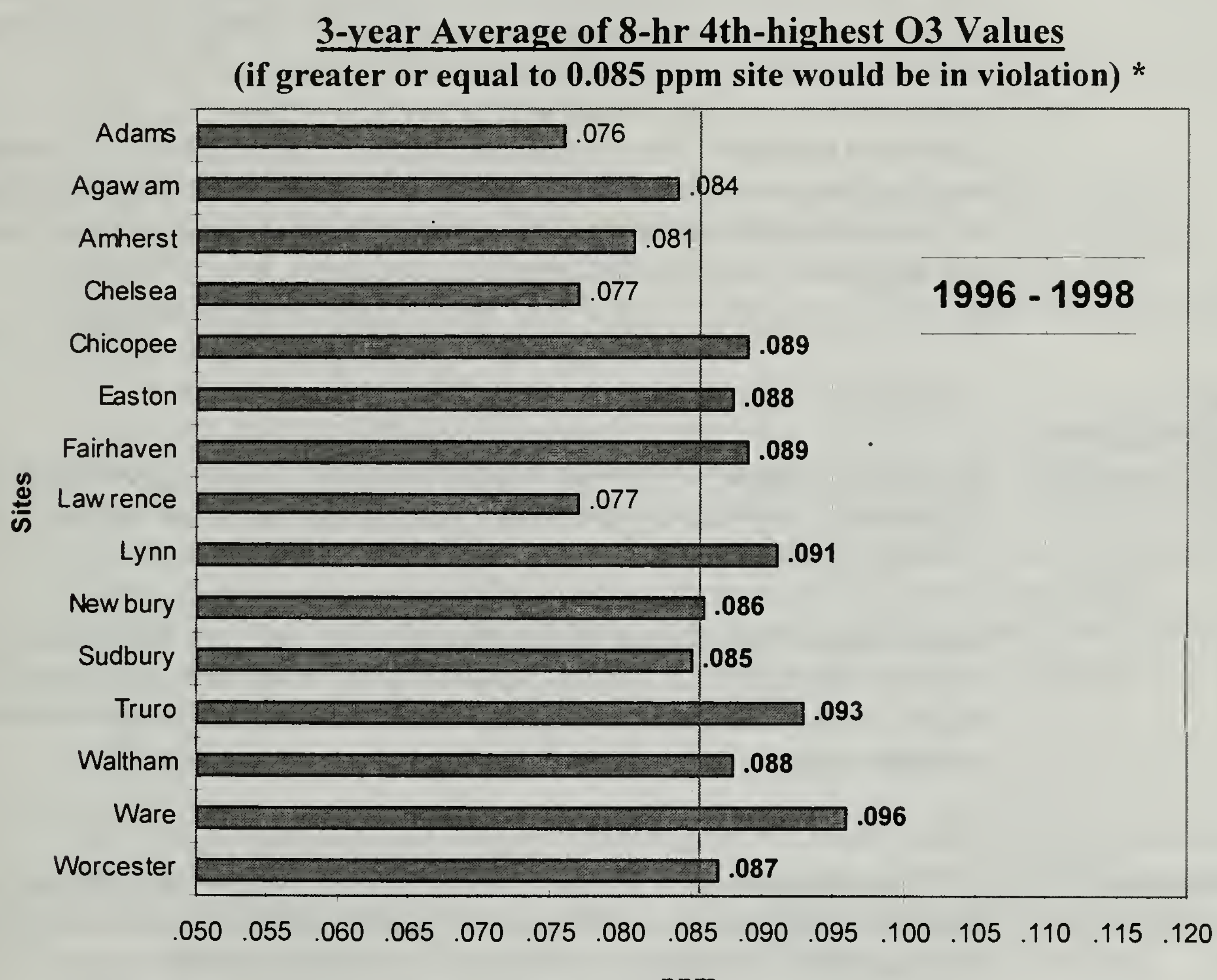

Figure 15

*FOR REFERENCE ONLY. Data from 1997–1999 will be used for regulatory purposes.

A Look at the 1998 Ozone (O3) Season

The new 8-hour O3 standard

The USEPA finalized the new, more protective 8-hour O3 standard in 1997. Air is now classified as unhealthy when O3 measures 0.085 ppm, averaged over eight hours, instead of 0.125 ppm averaged over one hour, the old benchmark. This change means that, on some days, air quality previously called acceptable is now considered unhealthy.

How unhealthy was the air?

During the 1998 O3 season (April 1–September 30), Massachusetts monitors recorded 8-hour O3 exceedances on 12 days, far fewer than the four-year average, 20 days, prior to 1998. The total number of 8-hour exceedances throughout the state was 60 (not including a monitor at Stow that began in 1998), also down from the four-year average of 76.

The fewer unhealthy days, as discussed below, resulted from an unusually wet weather pattern in June. When warmer, sunnier days returned, so did high O3 levels. In fact, on those unhealthy air days in 1998, high O3 levels were as widespread as on any days in the previous four years.

Some facts about the 1998 O3 exceedances

The table on page 26 lists all of the 1998 O3 exceedances.

The state's dirtiest air day was August 24, when 11 monitors recorded O3 exceedances. On that day, the Worcester monitor recorded the state's highest 8-hour value of the season, 0.123 ppm.

Massachusetts experienced no O3 exceedances until late May, when a two-day episode occurred. Then, 48 days later on July 14, another episode, a four-day event began. During that episode, monitors recorded 30 exceedances. Five more exceedance days followed, with the final one on September 27.

Meteorology and impact on O3

For Massachusetts to be exceedance-free for 48 straight days during the summer is unusual. To explain this and other O3 fluctuations the season's weather patterns need to be examined, because weather and O3 are closely connected.

Massachusetts often experiences its first elevated O3 days in May, when the atmosphere transitions to summertime weather patterns. May, 1998, was no exception. It began cool and wet, and then ended quite warm to produce two days with exceedance-level O3. That warmth, however, was short-lived, as conditions abruptly changed, turning June cool and wet – memorably wet. It was not until late in the month that weather patterns conducive to high O3 redeveloped.

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Why June's O3 levels were low

June's odd weather was the result of an unusual (for the season) wind pattern high in the atmosphere, characterized by the re-establishment and strengthening of the polar jet stream over North America.

That jet, which had been in retreat during the previous "el nino" months, formed a deep trough over southeastern Canada, extending southward into the eastern US. This pulled unseasonably cool air southward and induced frequent storm development over the northeast US. The region received heavy rains and flooding. By late June, the polar jet weakened, allowing the return of summer-like conditions.

Other meteorological factors during 1998

Even after June's wet weather pattern ended, O3 still never reached extreme levels during the summer. This is partly attributed to two meteorological factors.

First, although the jet weakened and retreated into Canada, the trough's mean position remained over eastern North America. This permitted the fairly regular passage of cold fronts through New England, each ushering in clean air. This effectively prevented the occurrence of prolonged heat waves conducive to extended and severe O3 episodes.

Second, the Atlantic oceanic high-pressure area was positioned at a higher than usual latitude for much of the summer. Rather than occupying its usual position near Bermuda (the Bermuda high), it was often centered just south of Nova Scotia. Thus, when Massachusetts was within the circulation of this high, wind components were more southerly than westerly. This likely kept the core of the east coast urban pollutant plume to our west. It also drew cleaner, marine air onshore at the Fairhaven and Truro monitors on the southeast coast, where no 8-hour O3 exceedances occurred from June through August.

Is air quality improving?

Measured O3 data indicate the air is cleaner than it was ten years ago, and continued improvement can be expected in the future. This can be attributed in large part to the effectiveness of the regulatory programs in place that have lead to less pollution from many sources, including: cars, gasoline, industrial boilers, electric generating facilities, paints, and household products.

See the State Implementation Plan (SIP) summary on page 34 for more information about Massachusetts efforts to reduce pollution.

Daily Ozone (O3) Forecast

Introduction

MADEP forecasts air quality daily from May through September during the O3 season. Each day during that period, MADEP predicts the air quality as good, moderate, or unhealthy.

Determining the air quality level rating

The air quality rating is determined through analysis of National Weather Service observations and weather modeling predictions. Also, meteorological, O3, and nitrogen oxides data is used from the statewide and regional monitoring networks.

The air quality ratings

The table below gives information about the ratings used in the daily air quality forecasts.

Air Quality Rating	Adverse Health Effects	Ways to Protect Your Health
Good	None expected.	No precautions necessary.
Moderate	O3 levels in the upper part of this range may cause respiratory problems in some children and adults engaged in outdoor activities. These effects are of particular concern for those with existing lung problems.	People with respiratory diseases such as asthma and other sensitive individuals should consider limiting outdoor exercise and strenuous activities during the afternoon and early evening hours, when O3 levels are highest.
Unhealthy	As O3 levels increase, both the severity of the health effects and the number of people affected increase. Health effects include eye, nose, and throat irritation; chest pain; decreased lung function; shortness of breath; increased susceptibility to respiratory infection, and aggravation of asthma. It is important to be aware that individuals react differently when exposed to various O3 levels in the unhealthy range; some people experience problems at lower unhealthy levels, while others may not be affected until higher levels are reached.	In general, everyone should limit strenuous outdoor activity during the afternoon and early evening hours, when O3 levels are usually the highest. If you are particularly sensitive to O3, or if you have asthma or other respiratory problems, stay in an area where it's cool and, if possible, where it is air-conditioned. If you want to take action to minimize exposure to unhealthy O3 levels, you should consider scheduling outdoor exercise and children's outdoor activities in the morning hours, when O3 levels are generally lower.

Forecast availability

The daily air quality forecast is available May through September from MADEP's website (www.state.ma.us/dep/) or by calling the Air Quality Hotline (1-800-882-1497).

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Ozone maps

The USEPA maintains a couple of internet websites containing current and archived O3 maps and "real-time" O3 movies using O3 data that is provided by participating states. These sites are (www.epa.gov/region01/eco/dailyozone/ ozone.html). and (www.epa.gov/airnow/ozone.html).

State Implementation Plan (SIP)

Overview

The federal Clean Air Act requires states that are in non-attainment of a standard to develop and implement strategies to attain that standard. The State Implementation Plan (SIP) is the mechanism for documenting this process, and all revisions to the SIP must be approved by the USEPA.

Reasonable Further Progress SIP

The following list contains the measures that have been submitted to the EPA since 1993 as part of Massachusetts' "Reasonable Further Progress" toward attaining the ozone standard. Note that this is not a comprehensive list of air regulations, as there are many MADEP air regulations which are not specifically credited in the Reasonable Further Progress SIP.

Air Pollution Programs in the Reasonable Further Progress Toward O3 Attainment SIP

Stationary Point Source Controls:
- Reasonably Available Control Technology (RACT) for 50 Ton VOC Sources (310 CMR 7.18)
- RACT for 50 Ton NOx Sources (310 CMR 7.19)

Stationary Area Source Controls:
- Reformulated Architectural and Industrial Maintenance Coatings (310 CMR 7.25)
- Reformulated Traffic Markings (310 CMR 7.25)
- Reformulated Consumer and Commercial Products (310 CMR 7.25
- Automotive Refinishing Controls (310 CMR 7.18)

On-Road Mobile Source Controls:
- Stage II Vapor Recovery Systems at Gasoline Stations (310 CMR 7.24)
- Federal Reformulated Gasoline
- Enhanced Automobile Inspection and Maintenance (I/M) up to 10,000 Gross Vehicle Weight Rating (310 CMR 60.02)
- Low Emission Vehicle (LEV) Program (310 CMR 7.40)
- Federal Motor Vehicle Program (FMVCP) - Pre-Clean Act New Engine Performance Standards
- Federal Tier I New Engine Performance Standards
- Traffic Flow Improvements

Off-Road Mobile Source Controls:
- Federal Reformulated Gasoline for Off-Highway Equipment
- Federal New Engine Performance Standards for Off-Highway Equipment

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Attainment Demonstration SIP

In July 1998, MADEP submitted an Attainment Demonstration SIP to EPA. In it, MADEP demonstrated that some additional VOC and NOx reductions in Massachusetts, coupled with large-scale regional NOx reductions, would likely allow Massachusetts to attain the one-hour O3 standard.

The VOC and NOx reduction in Massachusetts will come from:

- Additional federal measures (e.g., off-road and locomotive engine standards)
- Final completion of Massachusetts' previous SIP measures
- Enhancement of Massachusetts Stage II enforcement program
- Municipal Waste Combustor NOx Reductions (to be implemented in 2000)
- NOx Allowance Trading Program (310 CMR 7.27 to be revised in 9/99)

MADEP expects that the regional NOx reductions will be achieved through compliance with the program known as the EPA NOx SIP Call (issued as final September 1998).

Section III

Massachusetts Air Quality Data Summaries

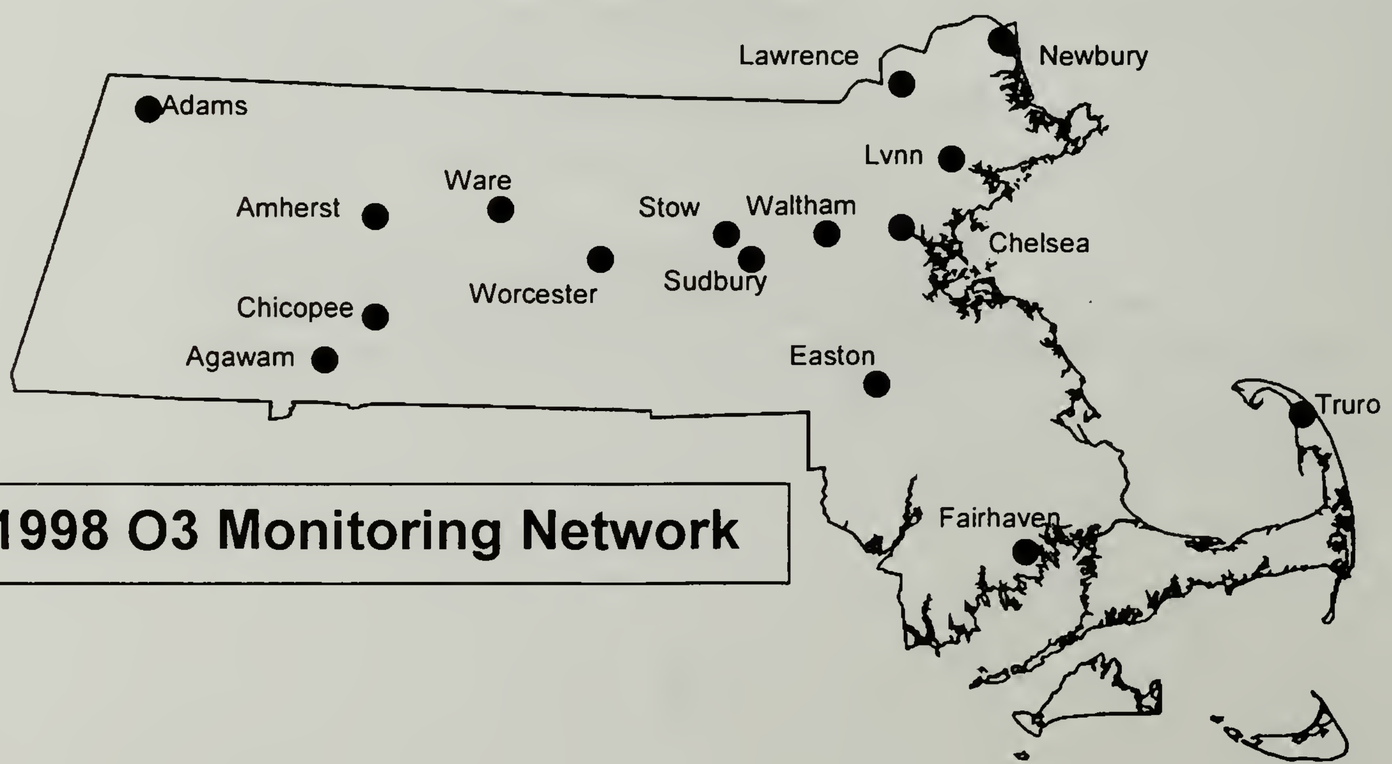
Ozone (O3) Summary

Introduction There were sixteen O3 sites during 1998 in the state-operated monitoring network. All of the sites achieved the requirement of 75% or greater data capture for the year except for the site on Mt. Greylock in Adams (70%). The adverse weather conditions at this site necessitate a late start-up.

A summary of the 1998 data during O3 season (April 1 – Sept. 30) is listed below.

SITE ID	POC	MT	CITY	COUNTY	UNITS: PPM ADDRESS	% OBS	-1 HR MAX- 1ST	-1 HR MAX- 2ND	VALS >.125	-8-HR MAX IMA- 1ST	-8-HR MAX IMA- 2ND	-8-HR MAX IMA- 4TH	VALS >.085
25-003-4002	1	2	ADAMS	BERKSHIRE	MT. GREYLOCK	70	.082	.078	0	.076	.074	.069	0
25-013-0003	1	8	AGAWAM	HAMPDEN	152 S. WESTFIELD	98	.104	.094	0	.093	.082	.080	1
25-015-0103	1	2	AMHERST	HAMPSHIRE	NORTH PLEASANT	97	.112	.111	0	.100	.096	.081	2
25-025-1003	1	1	CHELSEA	SUFFOLK	POWDER HORN HILL	91	.105	.096	0	.095	.088	.087	4
25-013-0008	1	7	CHICOPEE	HAMPDEN	ANDERSON ROAD	94	.117	.115	0	.104	.102	.093	5
25-005-1005	1	7	EASTON	BRISTOL	BORDERLAND PARK	92	.115	.107	0	.105	.091	.088	7
25-005-1002	1	2	FAIRHAVEN	BRISTOL	L. WOOD SCHOOL	98	.110	.101	0	.099	.087	.083	2
25-009-0005	1	1	LAWRENCE	ESSEX	HIGH STREET	98	.102	.096	0	.088	.081	.076	1
25-009-2006	1	8	LYNN	ESSEX	390 PARKLAND AVE	96	.121	.113	0	.108	.105	.100	7
25-009-4004	1	7	NEWBURY	ESSEX	SUNSET BOULEVARD	95	.117	.108	0	.103	.096	.089	6
25-017-1102	1	2	STOW	MIDDLESEX	US MILITARY RESERV.	97	.115	.114	0	.109	.098	.090	5
25-017-1801	1	1	SUDBURY	MIDDLESEX	WATER ROW RD	96	.118	.100	0	.104	.091	.085	4
25-001-0002	1	2	TRURO	BARNSTABLE	FOX BOTTOM AREA	97	.119	.103	0	.110	.086	.084	2
25-017-4003	1	2	WALTHAM	MIDDLESEX	BEAVER STREET	99	.134	.113	1	.116	.100	.098	7
25-015-4002	1	7	WARE	HAMPSHIRE	QUABBIN SUMMIT	96	.128	.117	1	.110	.102	.093	6
25-027-0015	1	1	WORCESTER	WORCESTER	WORCESTER AIRPORT	97	.139	.124	1	.123	.109	.097	6

ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) .**MT** = MONITOR TYPE (1 = NAMS, 2 = SLAMS, 3 = OTHER, 7 = PAMS/NAMS, 8 = PAMS/SLAMS) **% OBS** = PERCENTAGE OF VALID DAYS MONITORED DURING O3 SEASON **IST, 2ND I-HR MAX** = MAXIMUM 1-HR VALUE FOR THE 1ST & 2ND HIGHEST DAY **VALS > 0.125** = NUMBER OF MEASURED DAILY 1-HR MAXIMUM VALUES GREATER THAN OR EQUAL TO 0 125 PPM (1-HR STANDARD) **IST, 2ND, 4TH 8-HR MAXIMA** = MAXIMUM 8-HR VALUE FOR THE 1ST, 2ND & 4TH HIGHEST DAY **VALS > 0.O85** = NUMBER OF MEASURED DAILY 8-HR MAXIMUM VALUES GREATER THAN OR EQUAL TO 0.085 PPM (8-HR STANDARD)



1998 O3 Monitoring Network

Maximum 1-hr O3 Values

The figures below display the 1st and 2nd daily maximum 1–hour values at each site during 1998. The 1st and 2nd maximum values are for different days.

O3 Maximum Daily 1-hour Values

Standard = 0.125 ppm

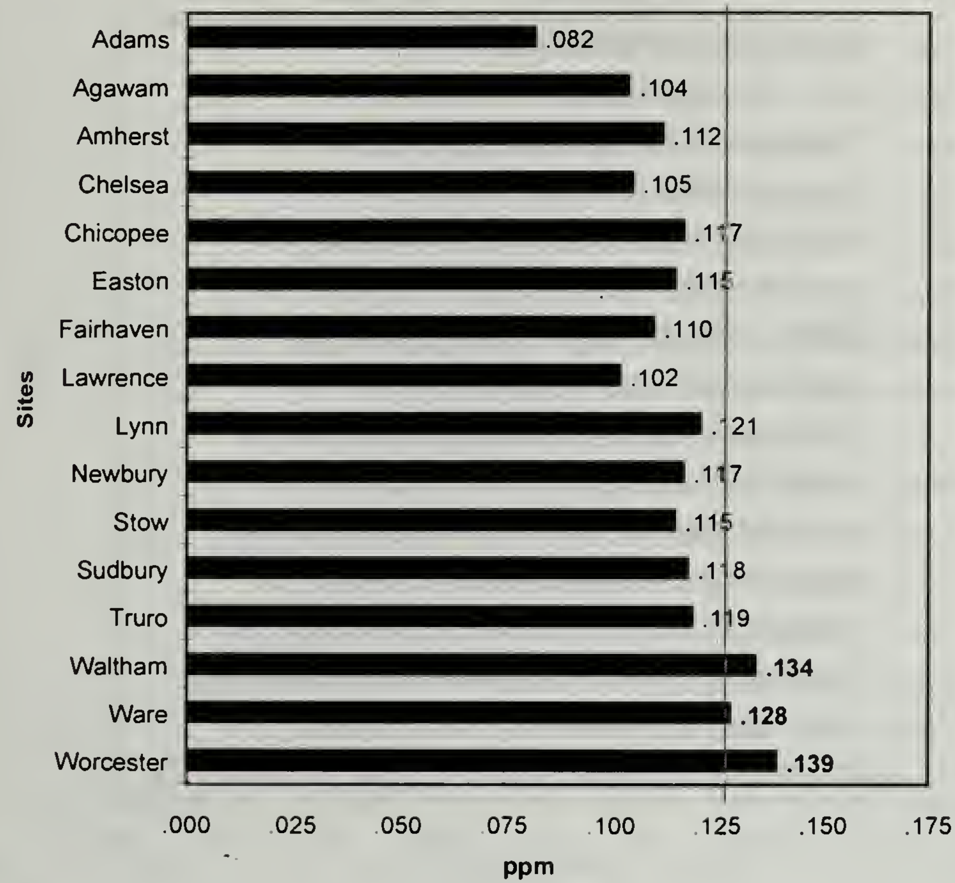


Figure 16

O3 2nd Maximum Daily 1-hour Values

Standard = 0.125 ppm

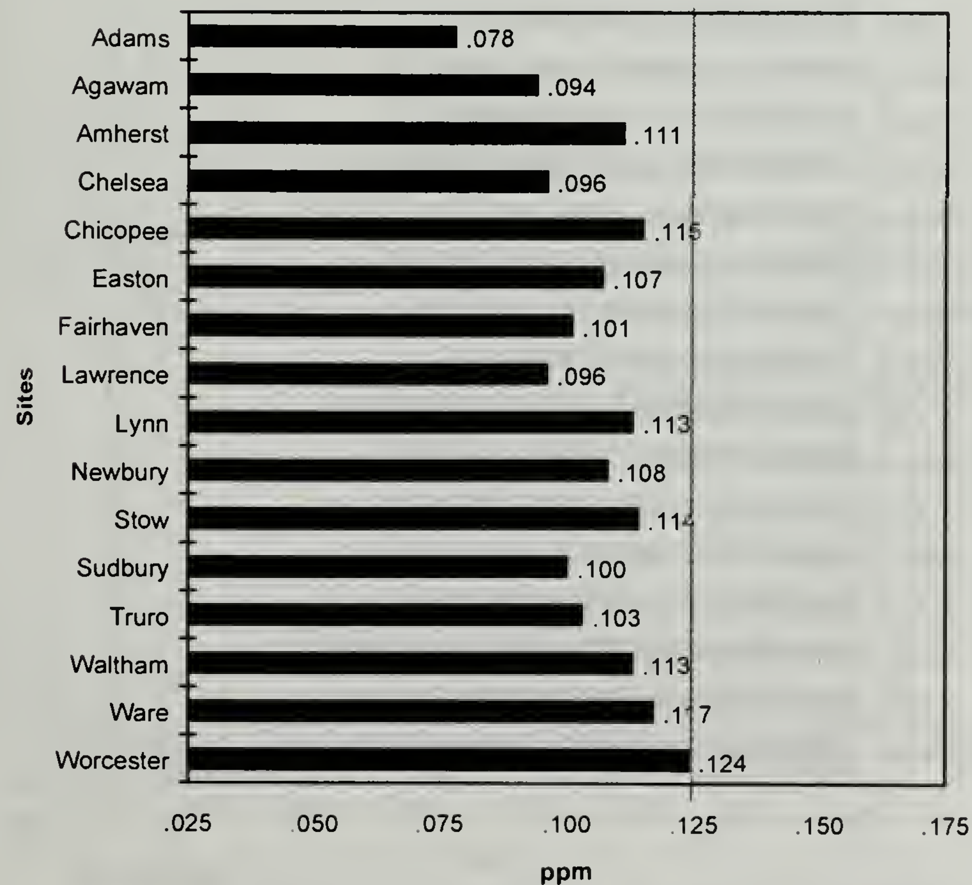


Figure 17

Ozone (O3) Summary, Continued

Maximum 8-hr O3 values

The 1st and 4th maximum daily 8-hour O3 values are shown below. A 3-year average of the 4th maximum value is used to determine attainment status.

<u>O3 Maximum Daily 8-hour Values</u>
Standard = 0.085 ppm

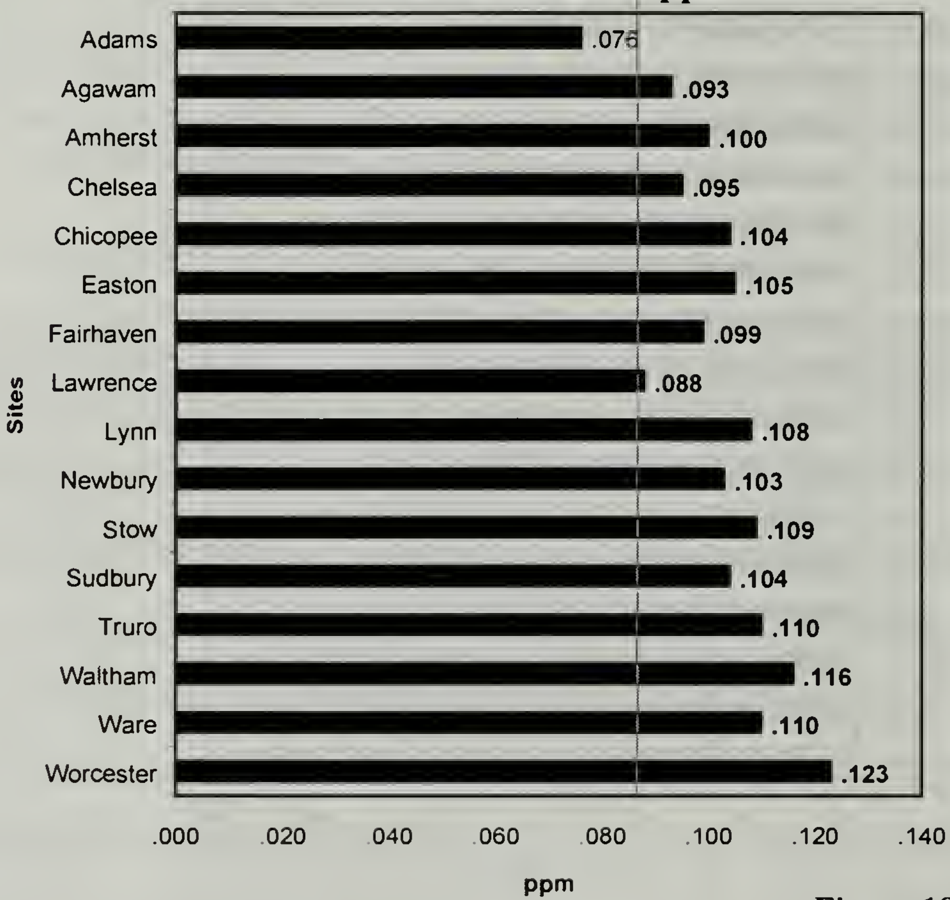


Figure 18

<u>O3 4th Maximum Daily 8-hour Values</u>
Standard = 0.085 ppm

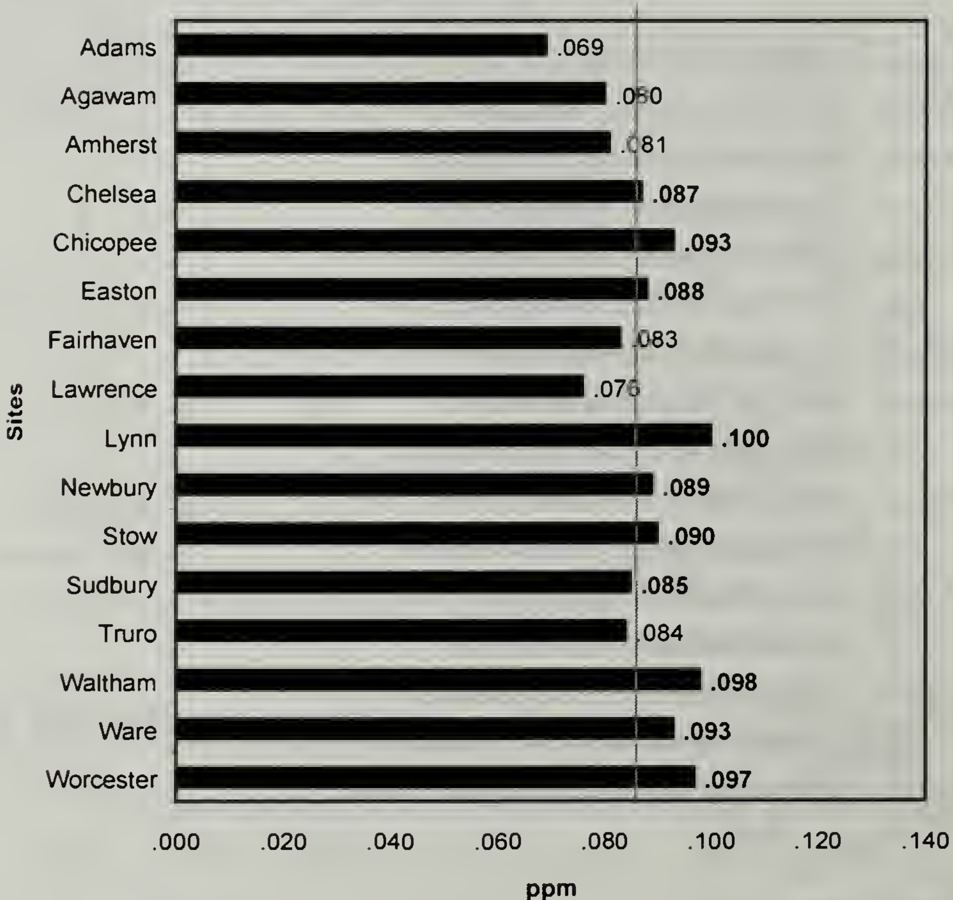


Figure 19

Ozone (O3) Summary, Continued

1-hour O3 exceedance day trends

The 10-year trends of 1-hour O3 exceedance days for each site are shown below.

<u>O3 1-hour Exceedance Day Trends</u>

number of days O3 exceeded the standard (0.125 ppm)

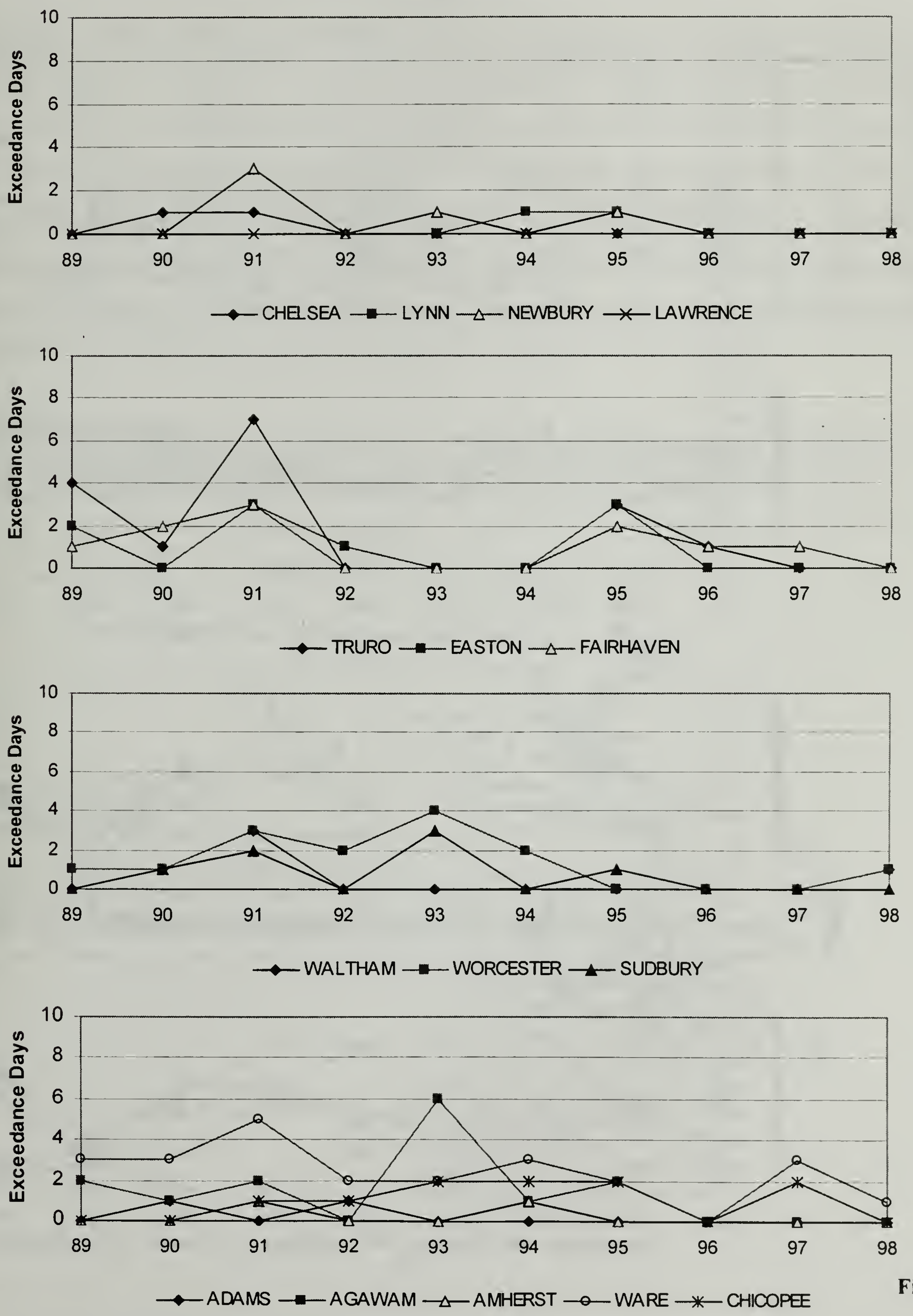


Figure 20

Ozone (O3) Summary, Continued

8-hour O3 exceedance day trends

The 10-year trends of 8-hour O3 exceedance days for each site are shown below.

<u>O3 8-hour Exceedance Day Trends</u>

number of days O3 exceeded the standard (0.085 ppm)

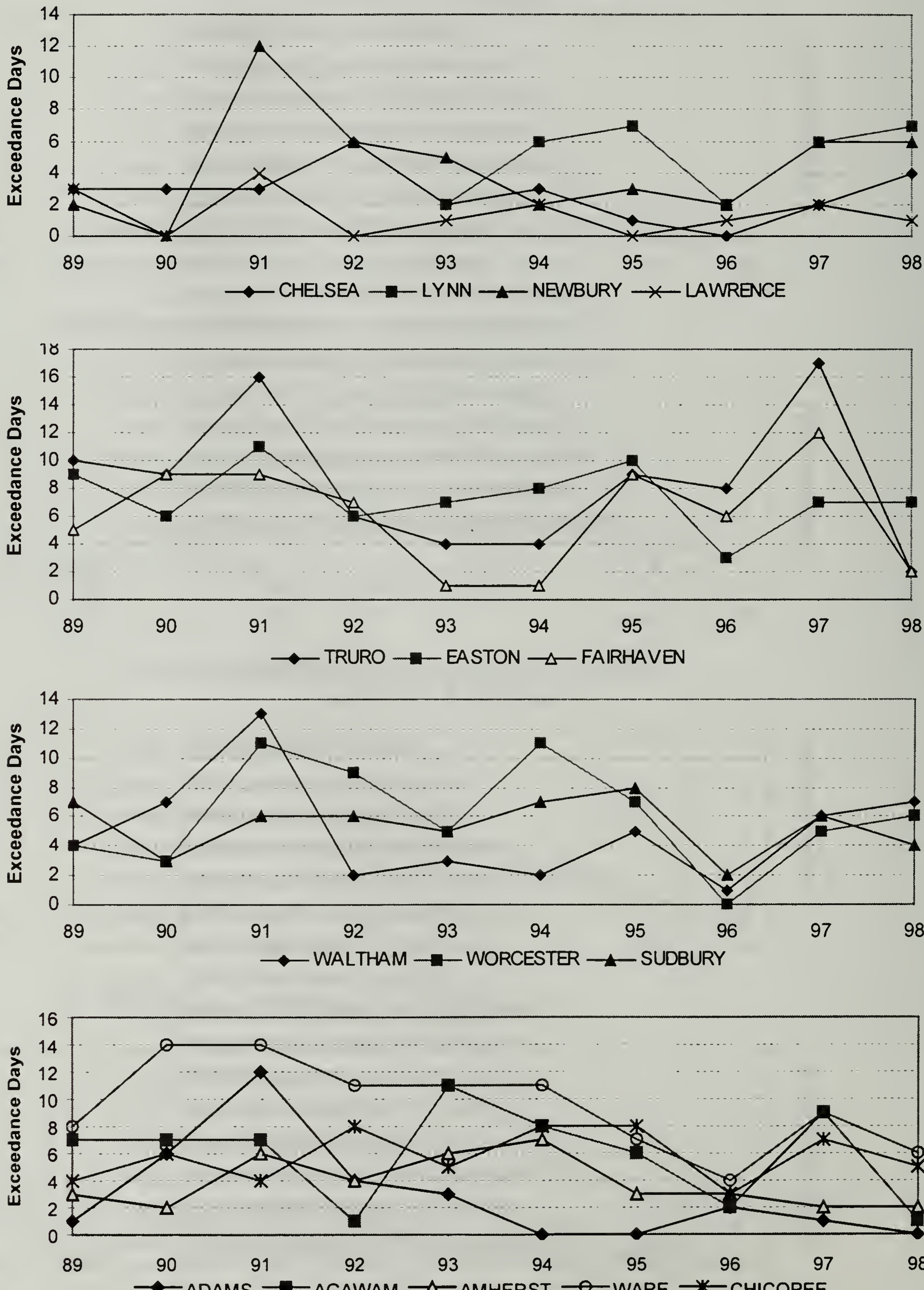


Figure 21

Sulfur Dioxide (SO2) Summary

Introduction

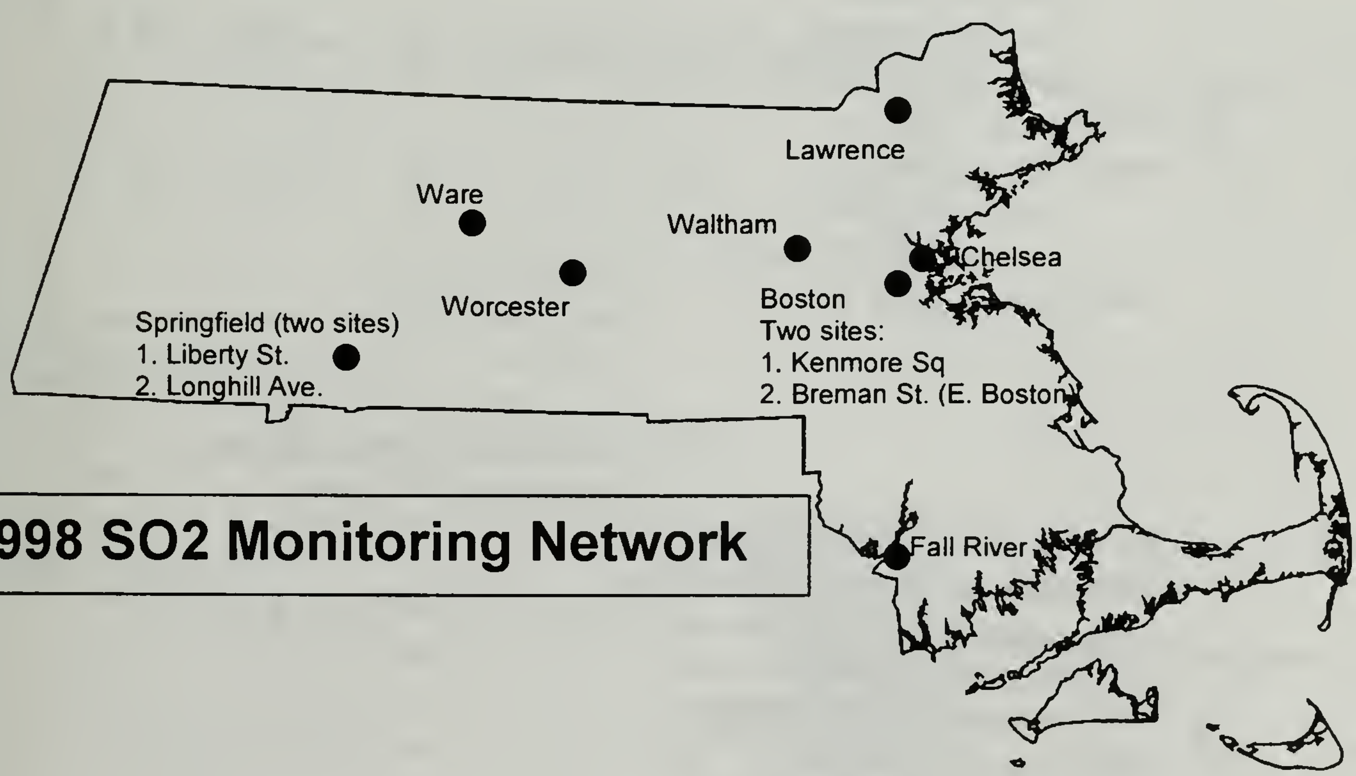
There were ten SO2 sites during 1998 in the state-operated monitoring network. All of the sites achieved the requirement of 75% or greater data capture for the year.

A summary of the 1998 data is listed below.

SITE ID	POC	MT	CITY	COUNTY	ADDRESS (UNITS:PPM)	% OBS	MAX 24-HR 1ST	MAX 24-HR 2ND	MAX 3-HR 1ST	MAX 3-HR 2ND	MAX 1-HR 1ST	MAX 1-HR 2ND	ANN ARITH MEAN
25-025-0002	1	1	BOSTON	SUFFOLK	KENMORE SQUARE	97	.031	.026	.054	.049	.094	.092	.010
25-025-0021	1	1	BOSTON	SUFFOLK	340 BREMAN ST.	98	.024	.023	.054	.046	.066	.064	.008
25-025-1003	1	1	CHELSEA	SUFFOLK	POWDERHORN HILL	98	.036	.025	.055	.051	.085	.084	.006
25-005-1004	1	1	FALL RIVER	BRISTOL	GLOBE STREET	97	.026	.024	.116	.070	.183	.146	.005
25-009-0005	1	1	LAWRENCE	ESSEX	HIGH STREET	93	.032	.031	.065	.057	.088	.085	.008
25-013-0016	1	1	SPRINGFIELD	HAMPDEN	LIBERTY STREET	91	.020	.019	.029	.027	.065	.037	.004
25-013-1009	1	1	SPRINGFIELD	HAMPDEN	LONGHILL STREET	91	.030	.026	.045	.038	.054	.047	.005
25-017-4003	1	1	WALTHAM	MIDDLESEX	BEAVER STREET	97	.023	.019	.049	.047	.098	.069	.005
25-015-4002	1	2	WARE	HAMPSHIRE	QUABBIN SUMMIT	97	.022	.016	.029	.029	.053	.035	.005
25-027-0020	1	1	WORCESTER	WORCESTER	CENTRAL STREET	96	.022	.017	.043	.032	.053	.047	.005

TO CONVERT UNITS FROM PPM TO uG/M³ MULTIPLY PPM x 2620

ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (1 = NAMS, 2 = SLAMS, 3 = OTHER) **REP ORG** = REPORTING ORGANIZATION **% OBS** = DATA CAPTURE PERCENTAGE **MAX 24-HR, MAX 3-HR, MAX 1-HR 1ST 2ND** = FIRST AND SECOND HIGHEST VALUE FOR TIME PERIOD INDICATED **OBS > .14** = NUMBER OF 24-HR AVG GREATER THAN 0.14 PPM (24-HR STANDARD) **OBS > .50** = NUMBER OF 3-HR AVG GREATER THAN 0.50 PPM (3-HR STANDARD) **ANN ARITH MEAN** = ANNUAL ARITHMETIC MEAN (STANDARD = 0.03 PPM)



1998 SO2 Monitoring Network

Summary of SO2 Values

The figures below present the 1998 data relative to the air quality standards. The 2nd-maximum value is displayed because it is the value that the 3-hour and 24-hour standards apply to. The highest 24-hour value occurred in Fall River, the highest 3-hour value was in Lawrence, and the highest annual mean was in Boston.

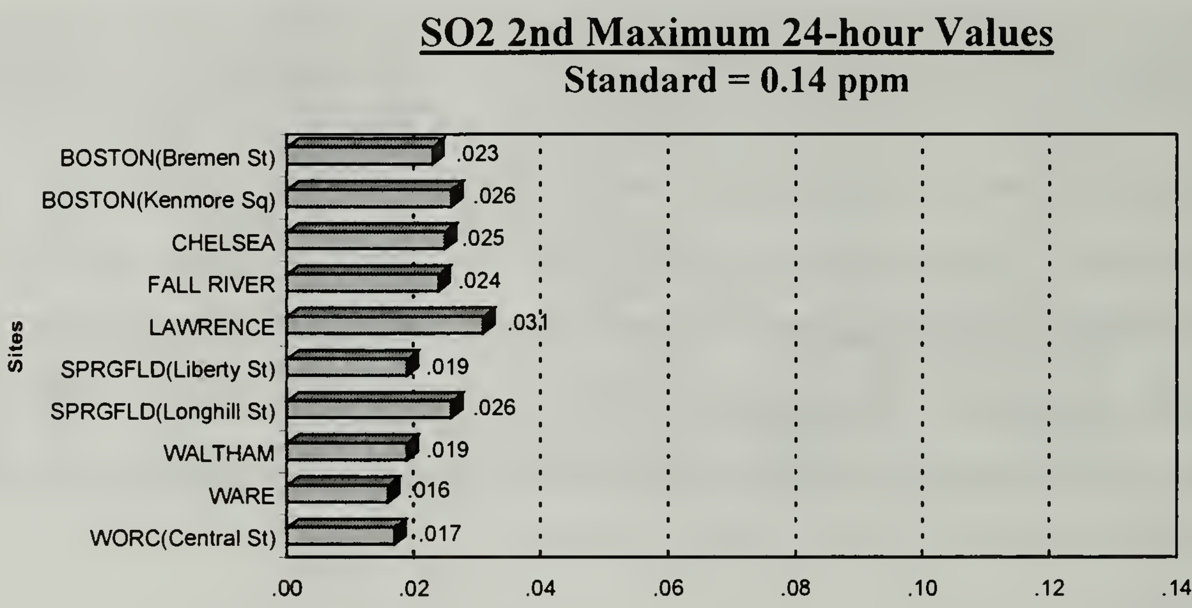


Figure 22

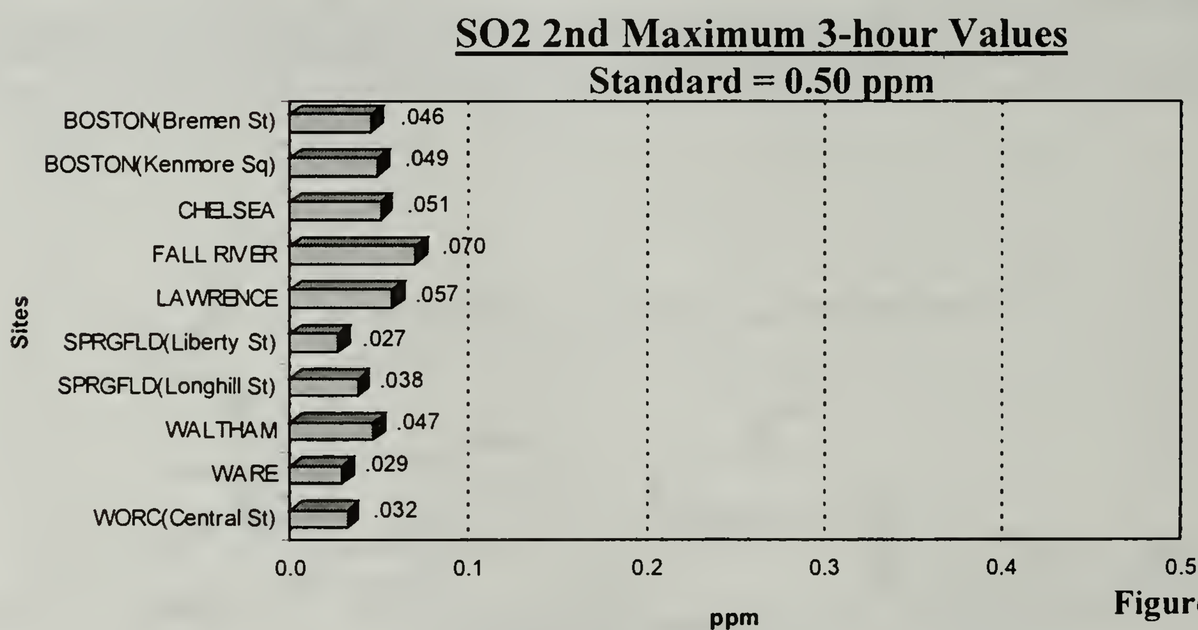


Figure 23

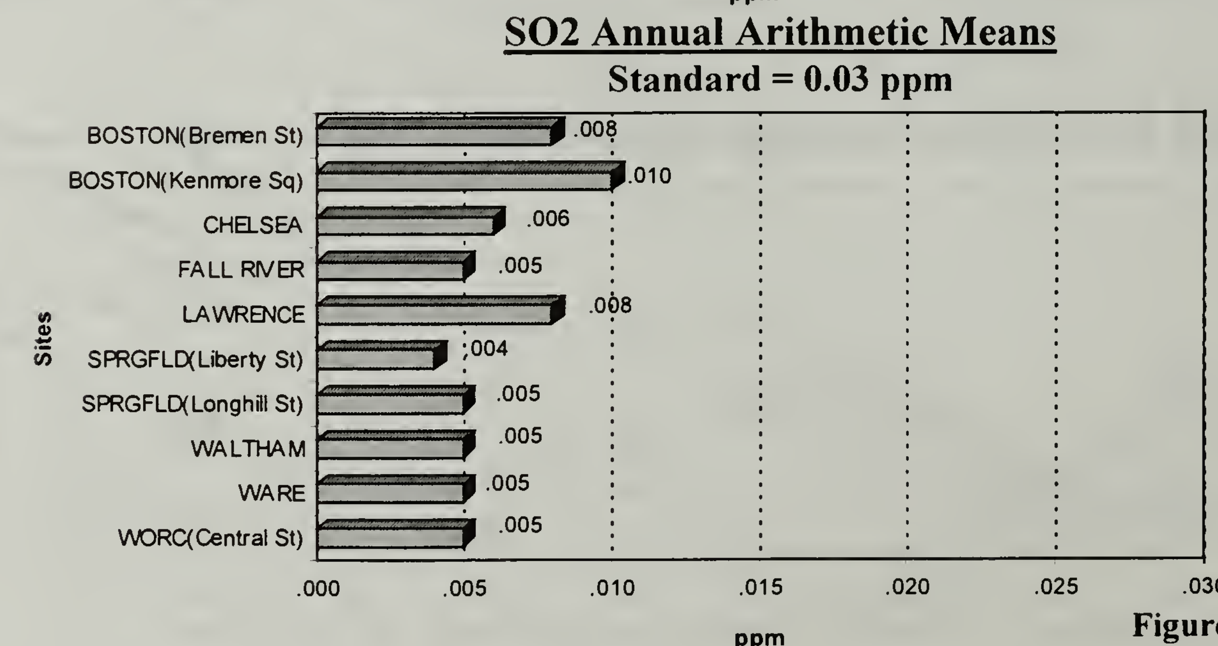


Figure 24

SO2 trends

The 10-year trends of the annual arithmetic means for each SO2 site are shown below. The trend has been stable the last few years and downward for the entire period. Massachusetts is below the standard.

SO2 10-year Trends
Annual Arithmetic Means
Standard = 0.03 ppm

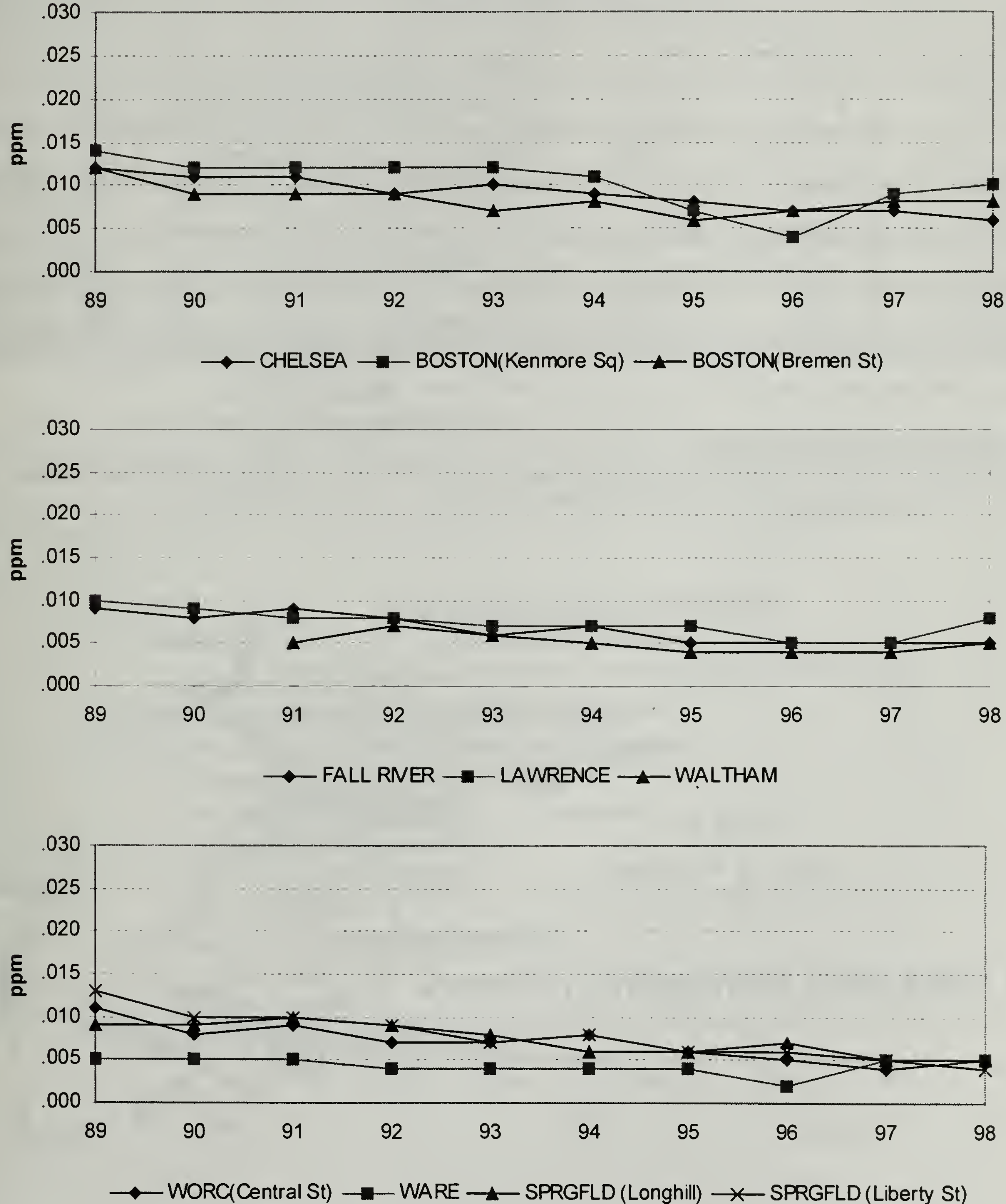


Figure 25

Nitrogen Dioxide (NO2) Summary

Introduction

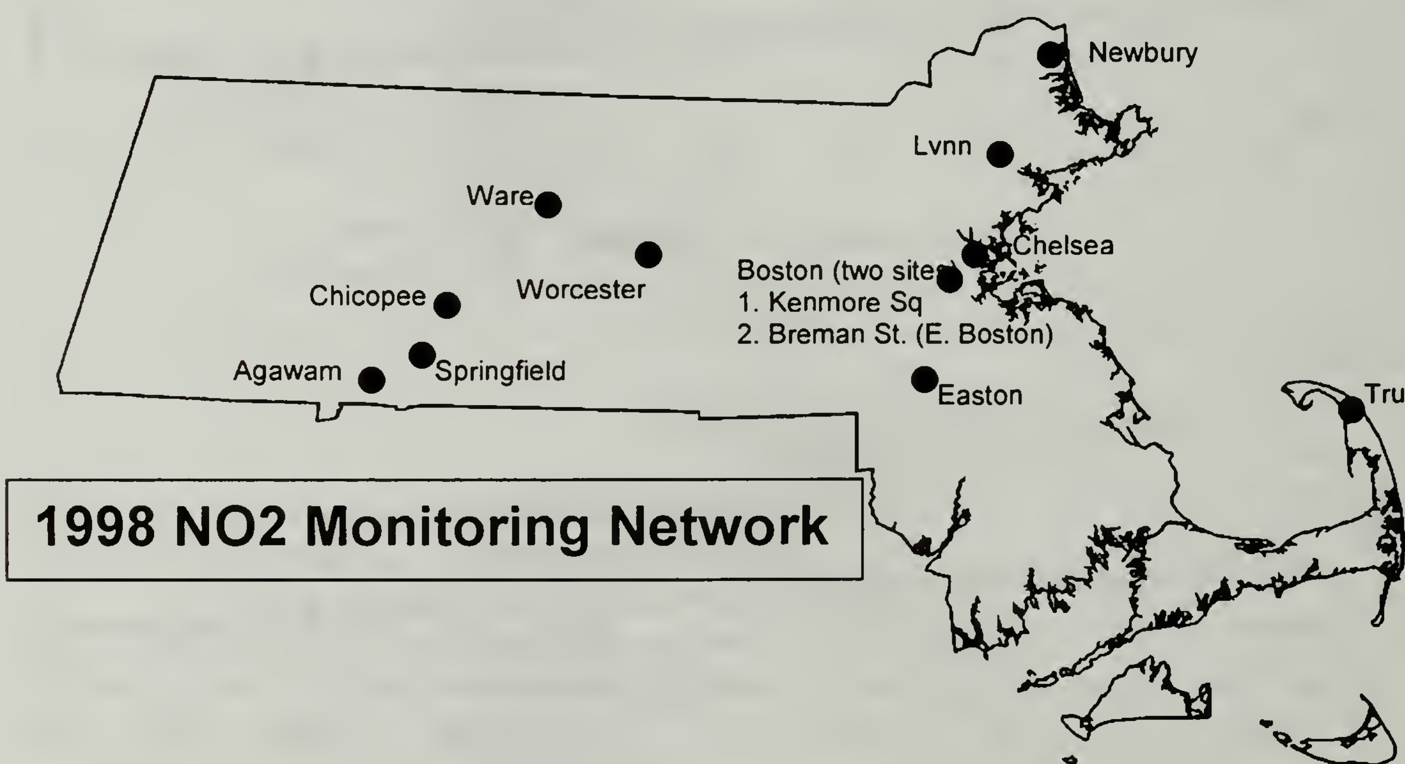
There were twelve NO2 sites during 1998 in the state-operated monitoring network. All of the sites achieved the requirement of 75% or greater data capture for the year.

A summary of the 1998 data is listed below.

SITE ID	POC	MT	CITY	COUNTY	UNITS: PPM ADDRESS	% OBS	MAX 1ST	1-HR 2ND	ARITH MEAN
25-013-0003	1	8	AGAWAM	HAMPDEN	152 SOUTH WESTFIELD STREET	92	.104	.080	.011
25-025-0002	1	3	BOSTON	SUFFOLK	KENMORE SQUARE	94	.112	.107	.031
25-025-0021	1	1	BOSTON	SUFFOLK	340 BREMAN STREET, EAST BOSTON	96	.083	.078	.028
25-025-1003	1	1	CHELSEA	SUFFOLK	POWDER HORN HILL	97	.091	.085	.023
25-013-0008	1	8	CHICOPEE	HAMPDEN	ANDERSON ROAD AIR FORCE BASE	95	.063	.058	.013
25-005-1005	1	8	EASTON	BRISTOL	1 BORDERLAND ST.	94	.041	.039	.008
25-009-2006	1	8	LYNN	ESSEX	390 PARKLAND AVE.	84	.077	.071	.015
25-009-4004	1	8	NEWBURY	ESSEX	SUNSET BOULEVARD	93	.070	.039	.006
25-013-0016	1	2	SPRINGFIELD	HAMPDEN	LIBERTY STREET PARKING LOT	90	.086	.067	.020
25-001-0002	1	U	TRURO	BARNSTABLE	FOX BOTTOM AREA-CAPE COD	82	.053	.040	.004
25-015-4002	1	8	WARE	HAMPSHIRE	QUABBIN SUMMIT	95	.048	.046	.006
25-027-0020	1	2	WORCESTER	WORCESTER	CENTRAL STREET FIRE STATION	89	.078	.065	.019

TO CONVERT UNITS FROM PPM TO uG/M³ MULTIPLY PPM x 1880

ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (1 = NAMS, 2 = SLAMS, 3 = OTHER, 7 = PAMS/NAMS, 8 = PAMS/SLAMS) **REP ORG** = REPORTING ORGANIZATION **% OBS** = DATA CAPTURE PERCENTAGE **MAX 1-HR 1ST 2ND** = FIRST AND SECOND HIGHEST VALUE FOR TIME PERIOD INDICATED **ARITH MEAN** = ANNUAL ARITHMETIC MEAN



NO2 data summary

The figures below present the 1998 data relative to the air quality standards. There is not a 1-hour ambient air quality standard, but there is one for the annual arithmetic mean. The highest mean occurred in Boston and was well below the standard.

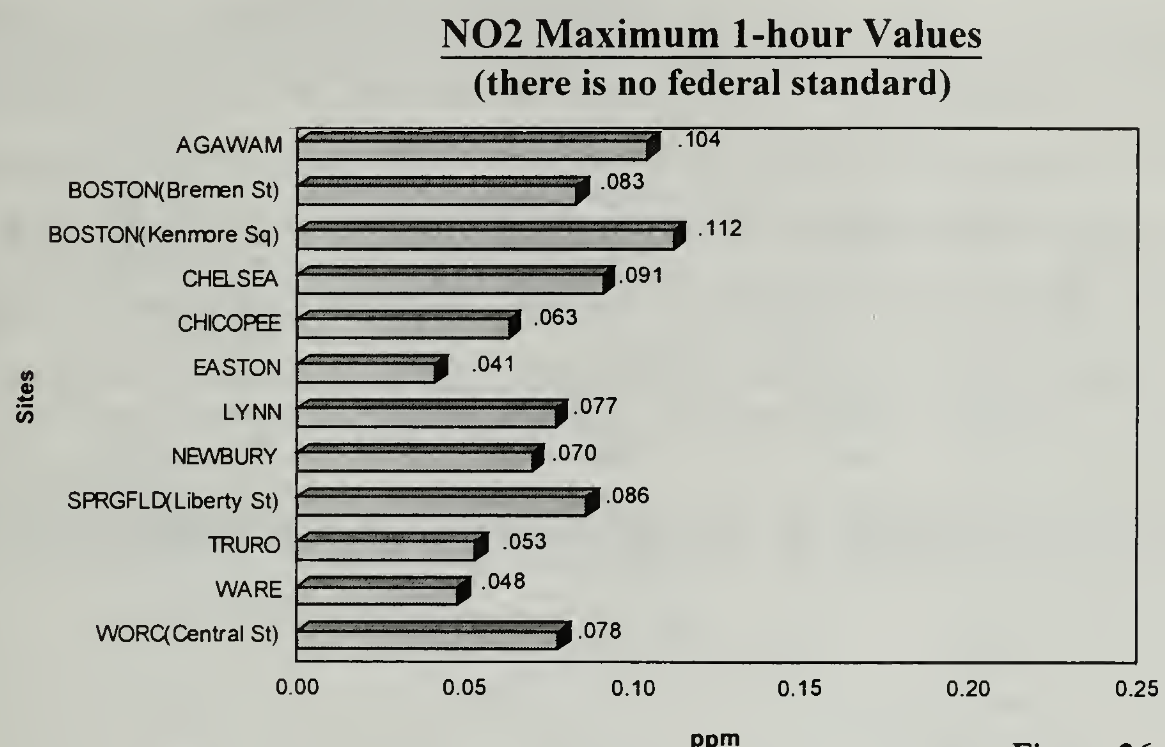


Figure 26

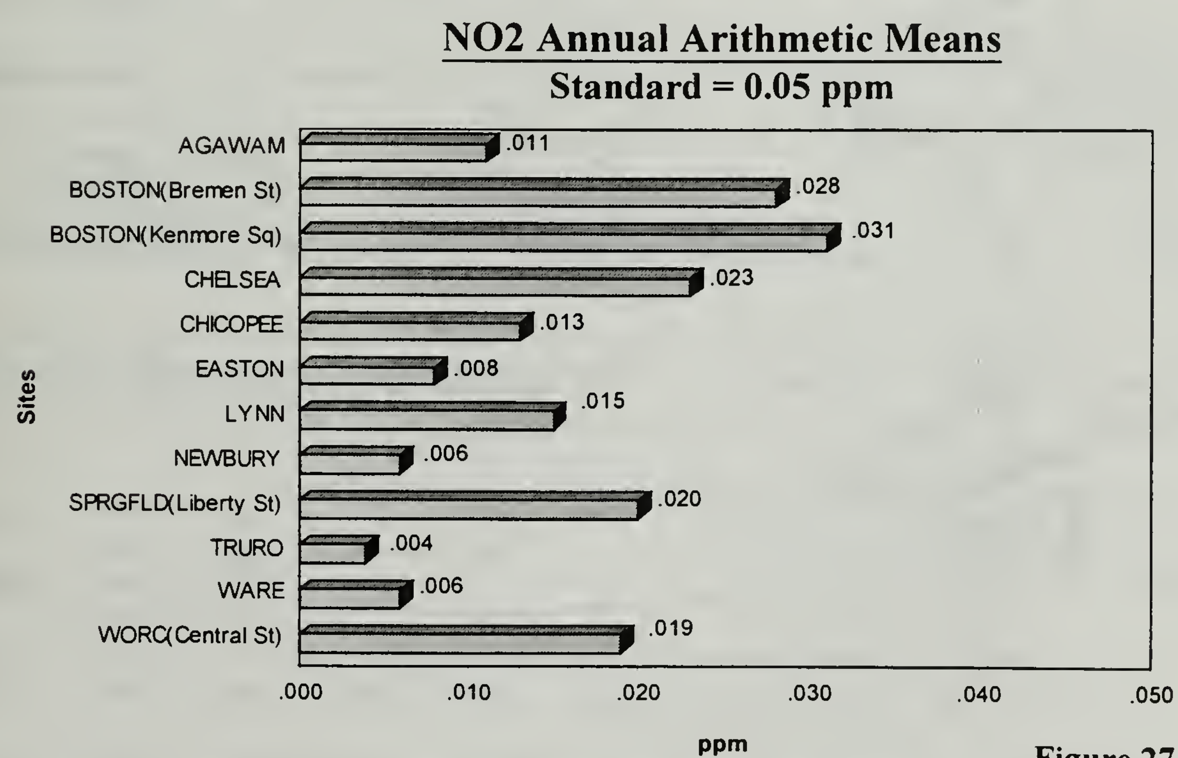
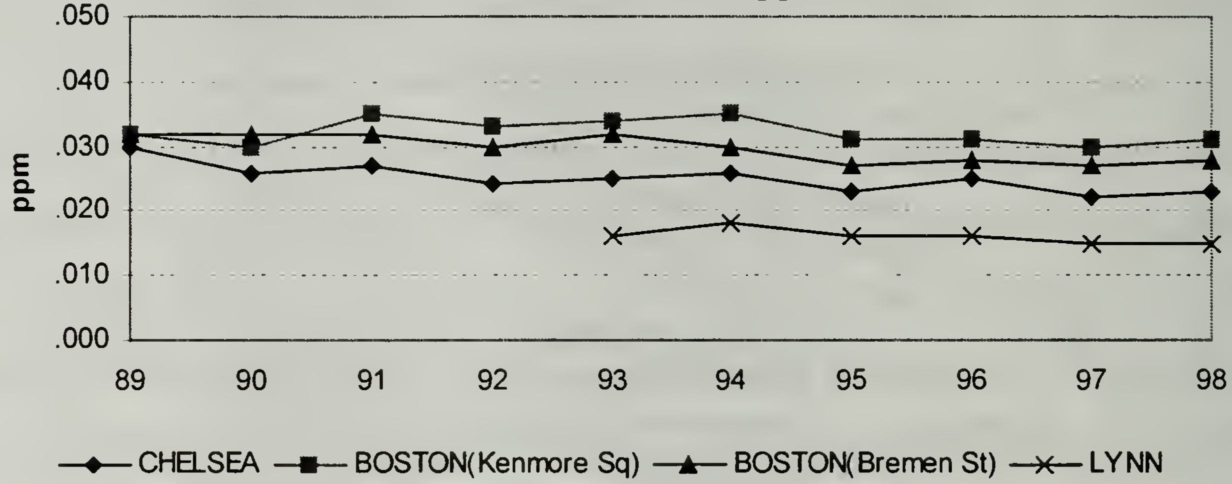


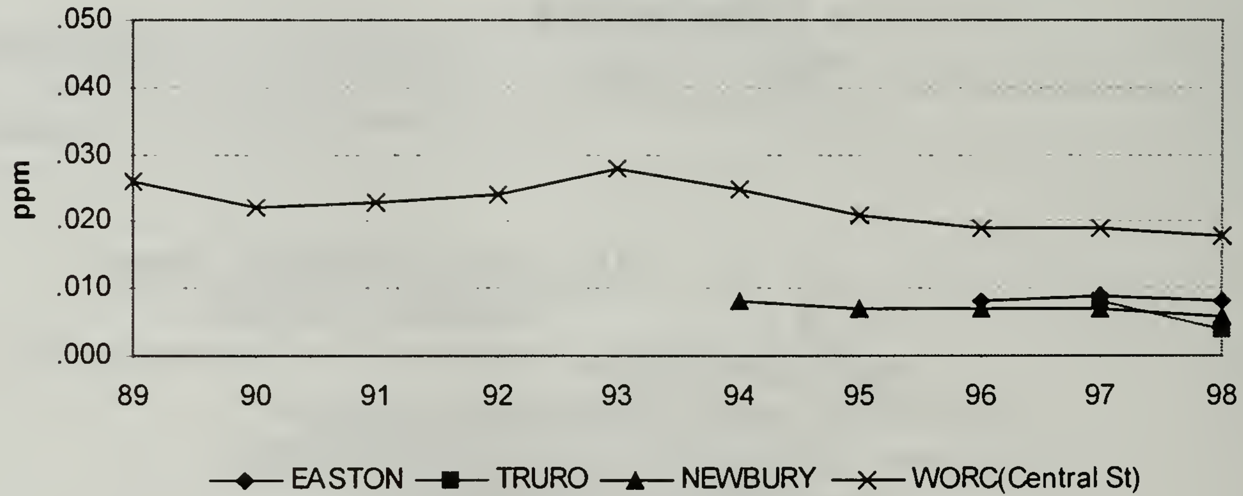
Figure 27

NO2 trends

The 10-year trends of the annual arithmetic means for each NO2 site are shown below. The trend has been stable the last few years and downward for the entire period. Massachusetts is below the standard.

<u>NO2 10-year Trends</u>
Annual Arithmetic Means
Standard = 0.05 ppm





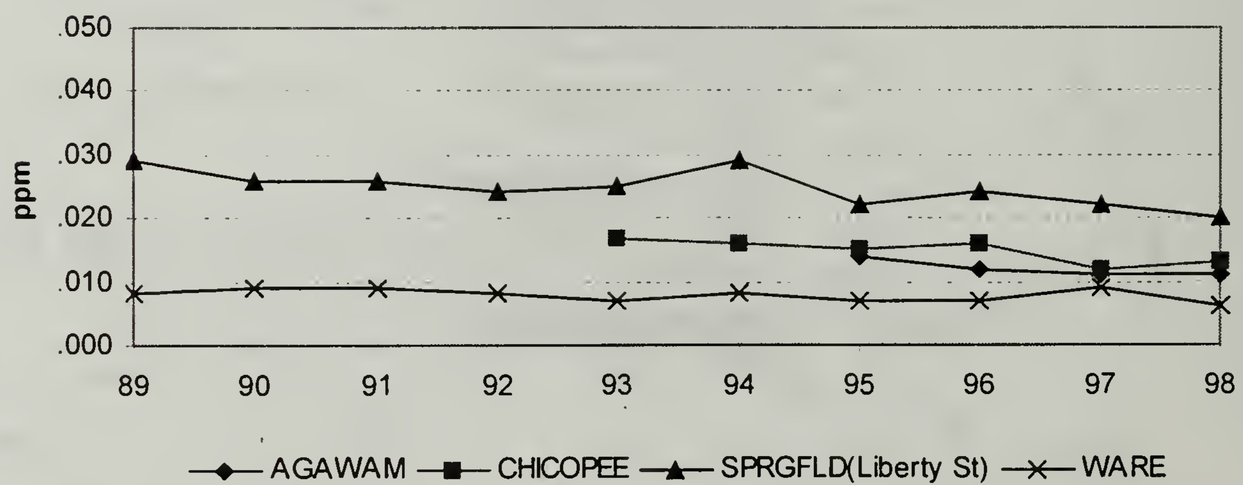


Figure 28

Carbon Monoxide (CO) Summary

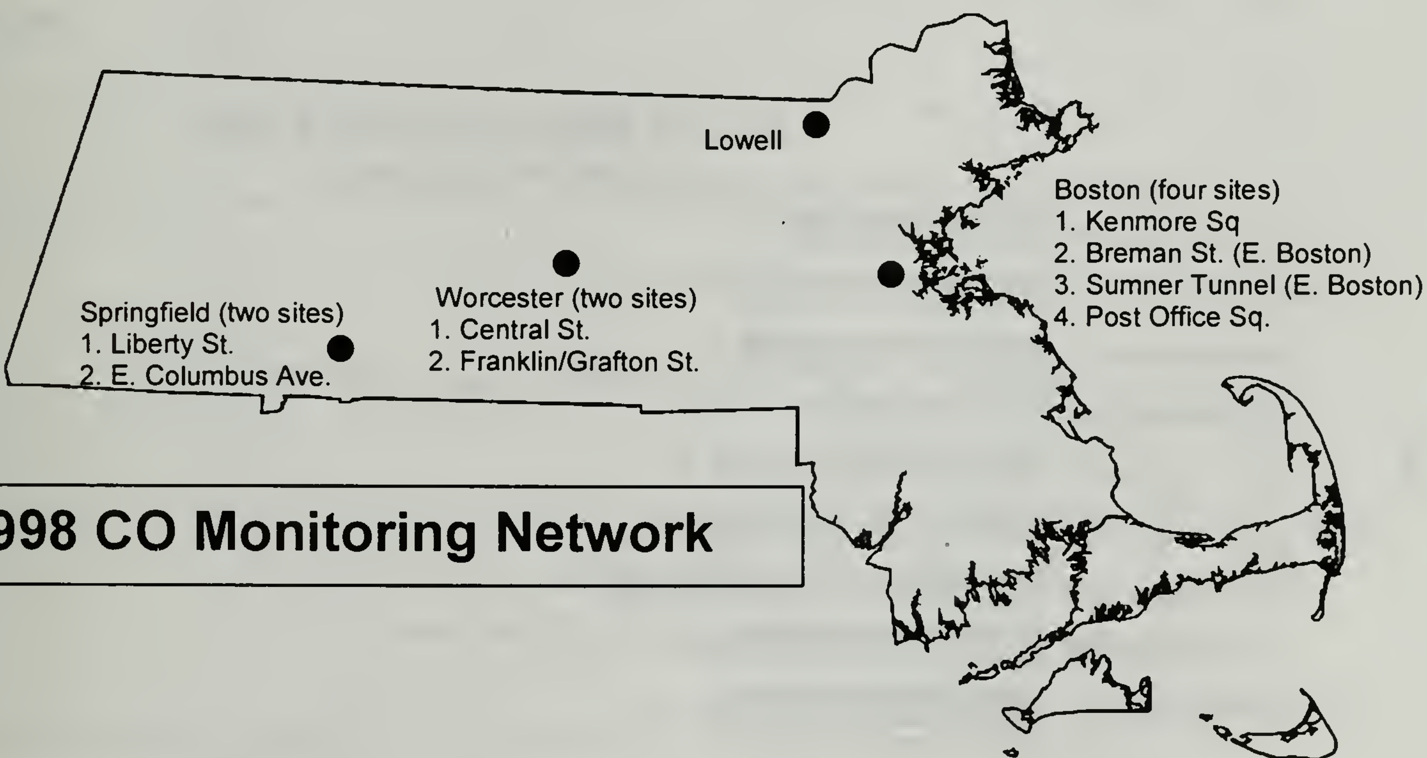
Introduction

There were nine CO sites during 1998 in the state-operated monitoring network. All of the sites achieved the requirement of 75% or greater data capture for the year.

A summary of the 1998 data is listed below.

SITE ID	POC	MT	CITY	COUNTY	UNITS: PPM ADDRESS	% OBS	MAX 1-HR 1ST	MAX 1-HR 2ND	OBS > 35	MAX 8-HR 1ST	MAX 8-HR 2ND	OBS > 9
25-025-0002	1	2	BOSTON	SUFFOLK	KENMORE SQ., 590 COMM. AVE	96	5.2	4.8	0	3.4	3.2	0
25-025-0016	1	2	BOSTON	SUFFOLK	SUMNER TUNNEL, EAST BOSTON	96	4.1	3.9	0	2.8	2.4	0
25-025-0021	1	1	BOSTON	SUFFOLK	340 BREMAN ST., E. BOSTON	95	5.8	4.7	0	2.7	2.6	0
25-025-0038	1	1	BOSTON	SUFFOLK	FEDERAL POST OFFICE BLDG	94	4.6	4.3	0	3.2	3.1	0
25-017-0007	1	2	LOWELL	MIDDLESEX	OLD CITY HALL, MERRIMACK ST	76	6.0	5.8	0	3.6	3.4	0
25-013-0016	1	1	SPRINGFIELD	HAMPDEN	LIBERTY STREET PARKING LOT	95	6.2	6.1	0	5.0	4.6	0
25-013-2007	1	1	SPRINGFIELD	HAMPDEN	EAST COLUMBUS AVENUE	89	5.3	5.2	0	4.5	3.6	0
25-027-0020	1	2	WORCESTER	WORCESTER	CENTRAL STREET FIRE STATION	86	5.9	5.1	0	4.1	3.5	0
25-027-0022	1	2	WORCESTER	WORCESTER	FRANKLIN/GRAFTON STREETS	89	7.5	4.9	0	3.9	3.5	0

ABBREVIATIONS AND SYMBOLS USED IN TABLE 15
SITE ID = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (1 = NAMS, 2 = SLAMS, 3 = OTHER) **% OBS** = DATA CAPTURE PERCENTAGE **MAX 1-HR 1ST 2ND** = FIRST AND SECOND HIGHEST VALUE FOR TIME PERIOD INDICATED **OBS > 35** = NUMBER OF 1-HR AVG GREATER THAN 35 PPM (1-HR STANDARD) **OBS > 9** = NUMBER OF 8-HR AVG. GREATER THAN 9 PPM (8-HR STD)



1998 CO Monitoring Network

CO data summary

The figures below present the 1998 data relative to the air quality standards. The 2nd-maximum value is displayed because it is the value that the standards apply to. Both the highest 1-hour and 24-hour values occurred in Springfield and were well within the standard.

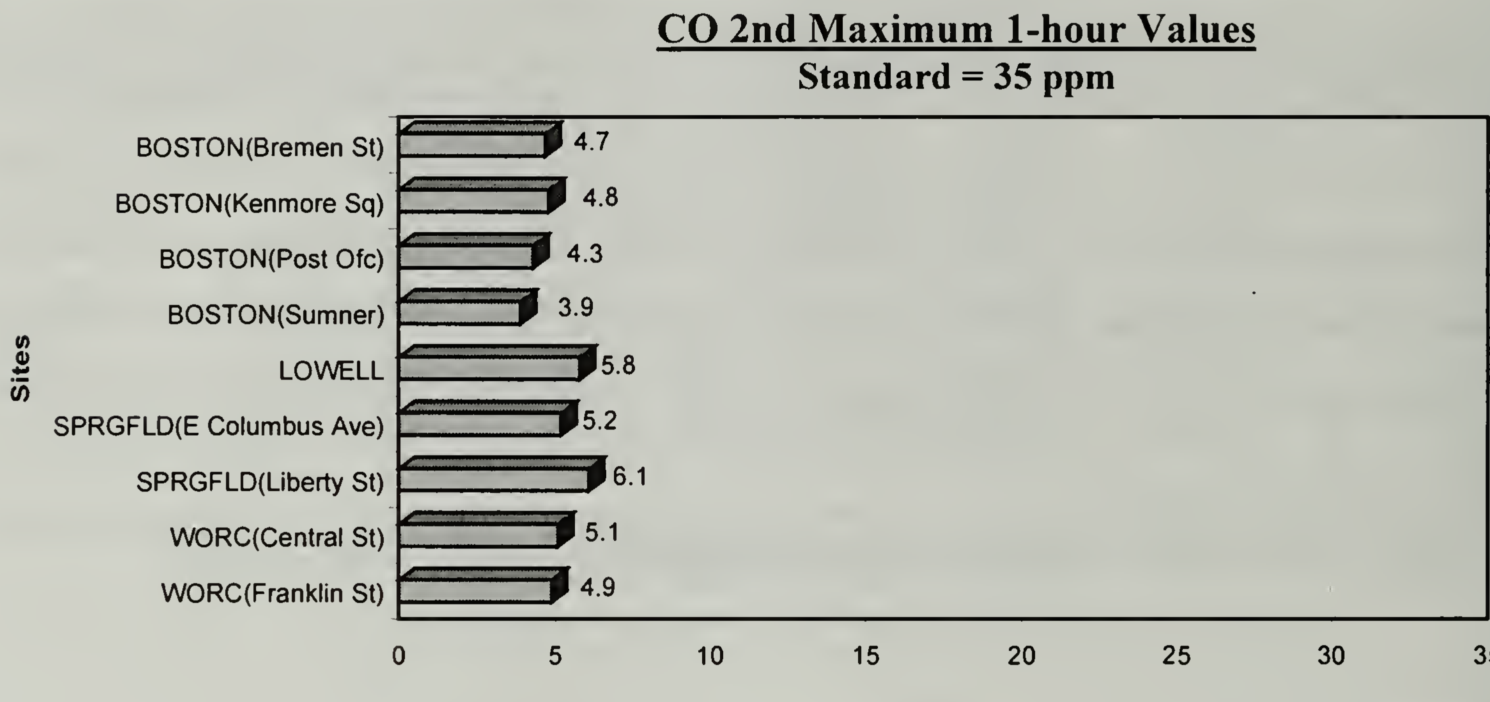


Figure 29

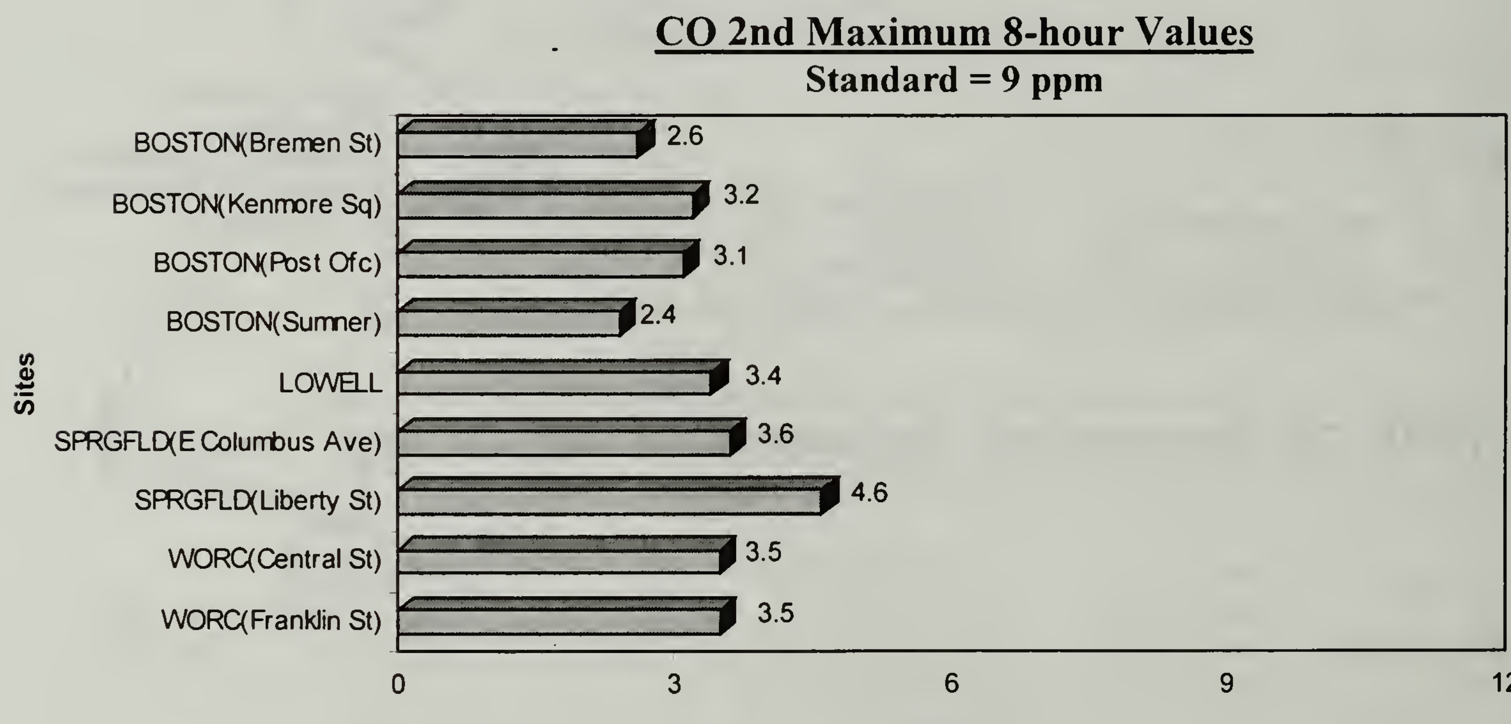


Figure 30

CO trends

The 10-year trends of the 2nd-maximum 8-hour value for each CO site are shown below. The data shows a yearly variability at most sites, with the overall trend being downward. Massachusetts is below the standard.

CO 10-year Trends
2nd Maximum 8-hour Values
Standard = 9 ppm

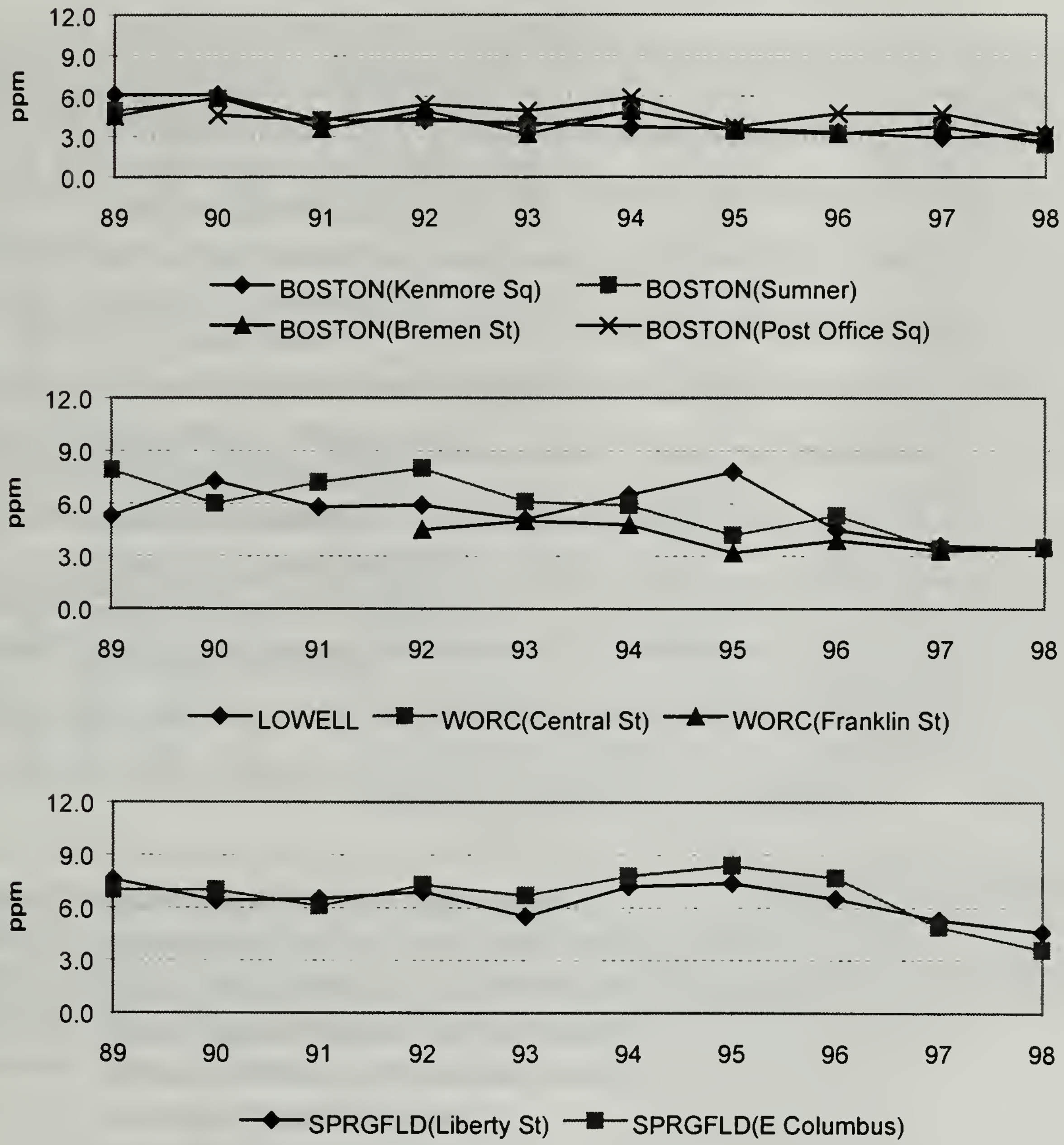


Figure 31

Particulate Matter 10-Microns (PM10) Summary

Introduction

There were sixteen PM10 sites (three sites had collocated monitors) during 1998 in the state-operated monitoring network. Eight of the sixteen sites achieved the requirement of 75% or greater data capture for each calendar quarter. All of the sites had greater than 75% data capture for the year. Sampler failures caused some quarters not to achieve the data capture requirement.

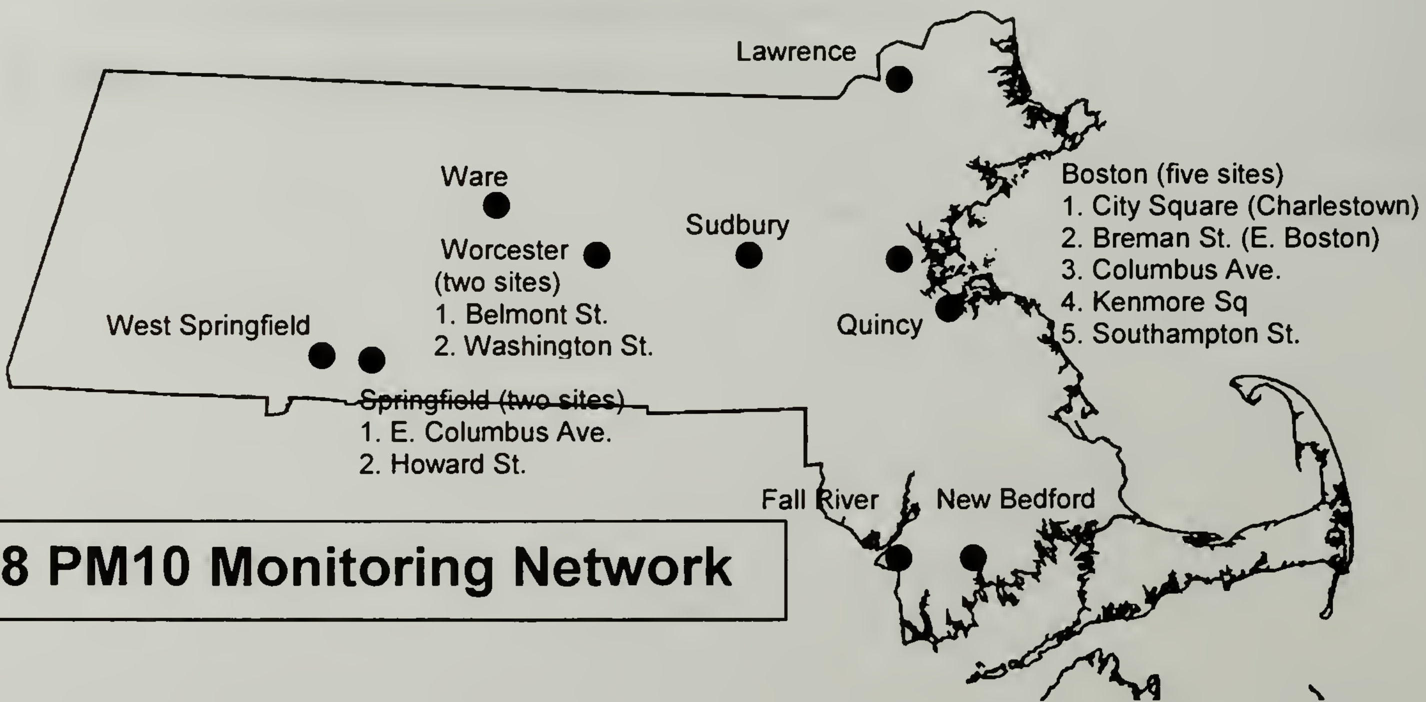
A summary of the 1998 data is listed below.

UNITS: UG/CU METER

SITE ID	POC	MT	CITY	COUNTY	ADDRESS	% OBS	-MAXIMUM 1ST	2ND	–VALUE- 3RD	4TH	VALS > 150 MEAS	> 150 EST	WTD ARITH MEAN
25-025-0002	1	1	BOSTON	SUFFOLK	KENMORE SQUARE	95	72	51	43	43	0	0.00	26
25-025-0012	1	1	BOSTON	SUFFOLK	115 SOUTHAMPTON ST.	82	67	64	59	53	0	0.00	26?
25-025-0012	2	3	BOSTON	SUFFOLK	115 SOUTHAMPTON ST.	48	69	44	42	39	0	0.00	29?
25-025-0021	1	2	BOSTON	SUFFOLK	340 BREMAN STREET	85	52	49	44	41	0	0.00	23?
25-025-0024	1	1	BOSTON	SUFFOLK	200 COLUMBUS AVE.	80	63	57	56	56	0	0.00	27?
25-025-0027	1	1	BOSTON	SUFFOLK	ONE CITY SQUARE	97	84	71	66	62	0	0.00	32
25-025-0027	3	3	BOSTON	SUFFOLK	ONE CITY SQUARE	51	59	59	58	57	0	0.00	33?
25-005-3001	1	2	FALL RIVER	BRISTOL	CENTRAL FIRE STATION	97	81	44	40	35	0	0.00	18
25-009-0005	1	2	LAWRENCE	ESSEX	HIGH STREET	89	41	39	33	32	0	0.00	15?
25-005-2004	1	2	NEW BEDFORD	BRISTOL	YMCA,25 WATER ST.	98	51	42	30	28	0	0.00	16
25-021-0007	1	2	QUINCY	NORFOLK	HANCOCK STREET	79	60	34	33	31	0	0.00	16?
25-013-0011	2	2	SPRINGFIELD	HAMPDEN	59 HOWARD STREET	93	51	50	44	43	0	0.00	21?
25-013-2007	1	1	SPRINGFIELD	HAMPDEN	EAST COLUMBUS AVE.	97	77	62	53	51	0	0.00	26
25-013-2007	3	3	SPRINGFIELD	HAMPDEN	EAST COLUMBUS AVE.	95	89	62	60	56	0	0.00	28
25-017-1801	1	2	SUDBURY	MIDDLESEX	WATER ROW RD	92	71	40	37	35	0	0.00	15
25-015-4002	1	2	WARE	HAMPSHIRE	QUABBIN SUMMIT	96	36	35	28	28	0	0.00	12?
25-013-5003	1	2	W. SPRINGFIELD	HAMPDEN	W. SPRINGFIELD FIRE	95	65	47	40	40	0	0.00	20
25-027-0013	1	2	WORCESTER	WORCESTER	419 BELMONT ST.	89	87	50	49	43	0	0.00	20
25-027-0016	1	1	WORCESTER	WORCESTER	2 WASHINGTON ST.	84	48	37	35	32	0	0.00	18?

? INDICATES THAT THE MEAN DOES NOT SATISFY SUMMARY CRITERIA (NUMBER OF OBSERVATIONS FOR AT LEAST 1 QUARTER < 75%)

ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (1 = NAMS, 2 = SLAMS, 3 = OTHER) **% OBS** = DATA CAPTURE PERCENTAGE **MAXIMUM VALUE 1ST, 2ND, 3RD, 4TH** = 1ST, 2ND, 3RD, AND 4TH HIGHEST 24-HOUR VALUES FOR THE YEAR **VALS > 150 MEAS** = NUMBER OF VALUES GREATER THAN 150 µg/m³ (PM-10 STANDARD) **VALS > 150 EST** = NUMBER OF EXPECTED VIOLATIONS **WTD ARITH MEAN** = WEIGHTED ANNUAL ARITHMETIC MEAN (STANDARD = 50 µg/m³) ? = INDICATES THAT NUMBER OF OBSERVATIONS WERE INSUFFICIENT TO CALCULATE MEAN THE DATA CAPTURE AT A SITE MUST EXCEED 75% FOR EACH QUARTER.



1998 PM10 Monitoring Network

Particulate Matter 10-Microns (PM10) Summary, Continued

PM10 data summary

The figures below present the 1998 data relative to the air quality standards. The highest 24-hour and annual arithmetic mean values each occurred in Boston. Both were well within the standards.

PM10 2nd Maximum 24-hour Values
Standard – 150 ug/m3

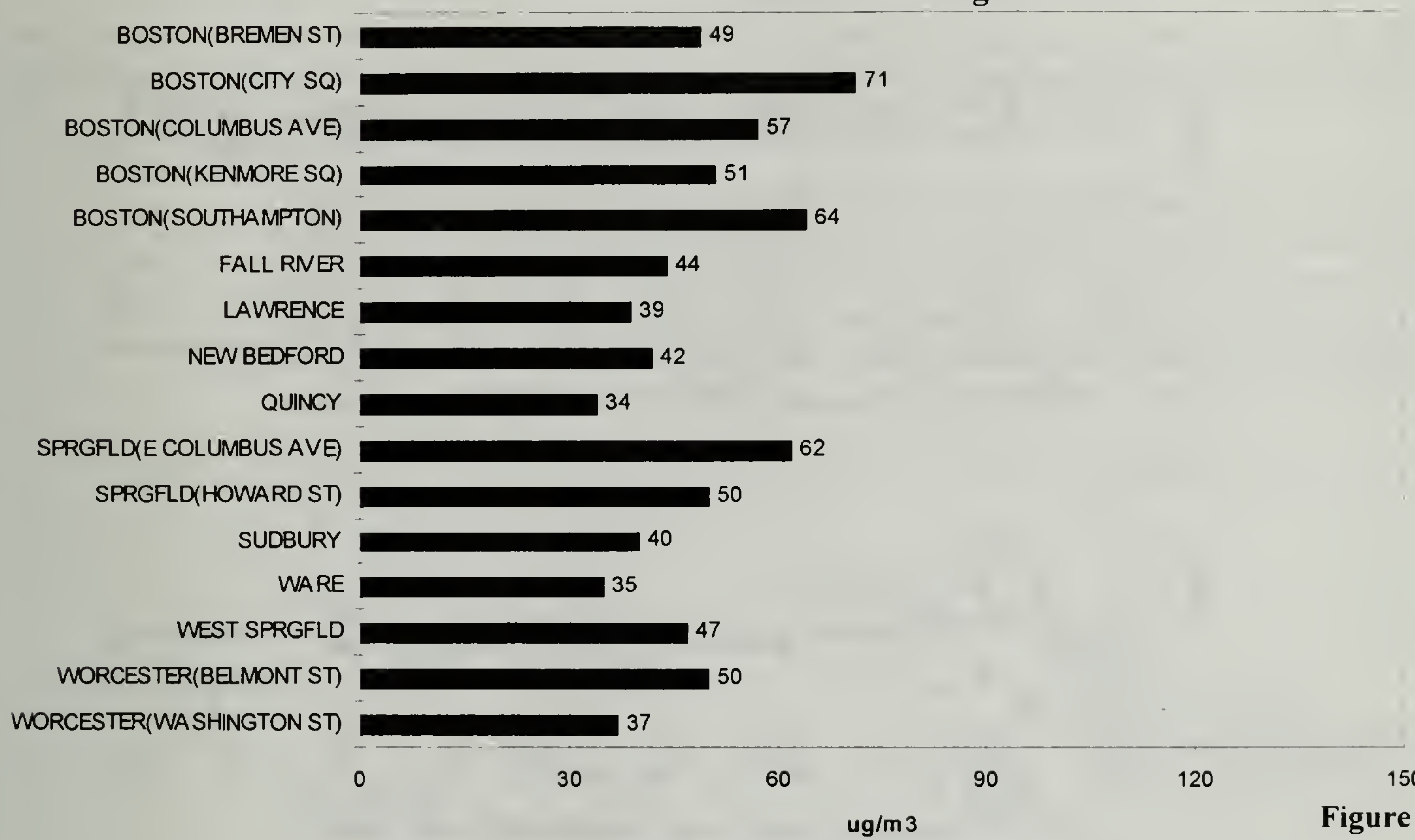


Figure 32

PM10 Annual Arithmetic Mean
Standard – 50 ug/m3

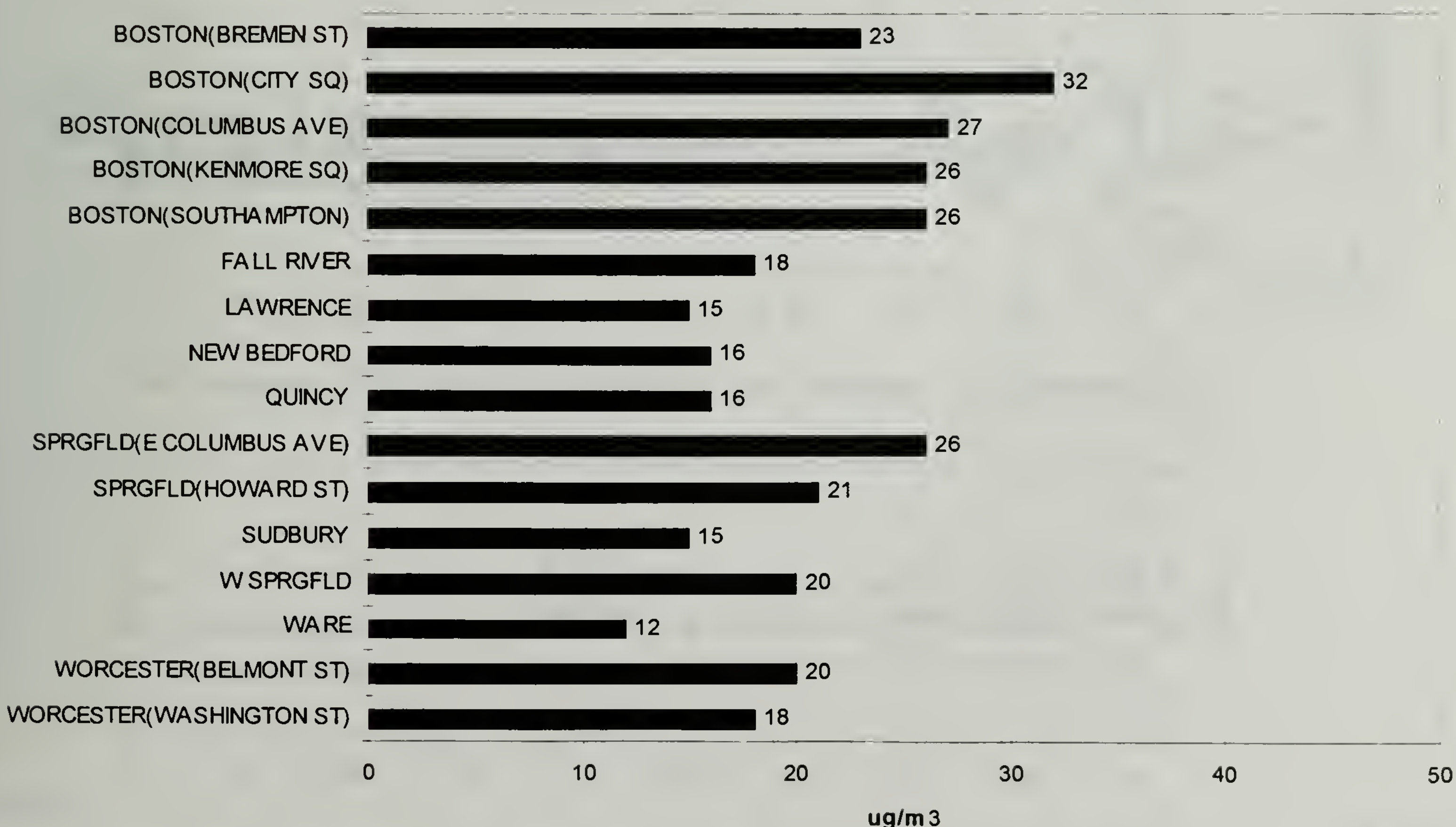


Figure 33

PM10 trends

PM10 10-year trends are shown of the annual arithmetic mean for each PM10 site. The data shows a yearly variability at most sites, with the overall trend downward.

PM10 10-year Trends

Annual Arithmetic Mean

Standard = 50 ug/m3

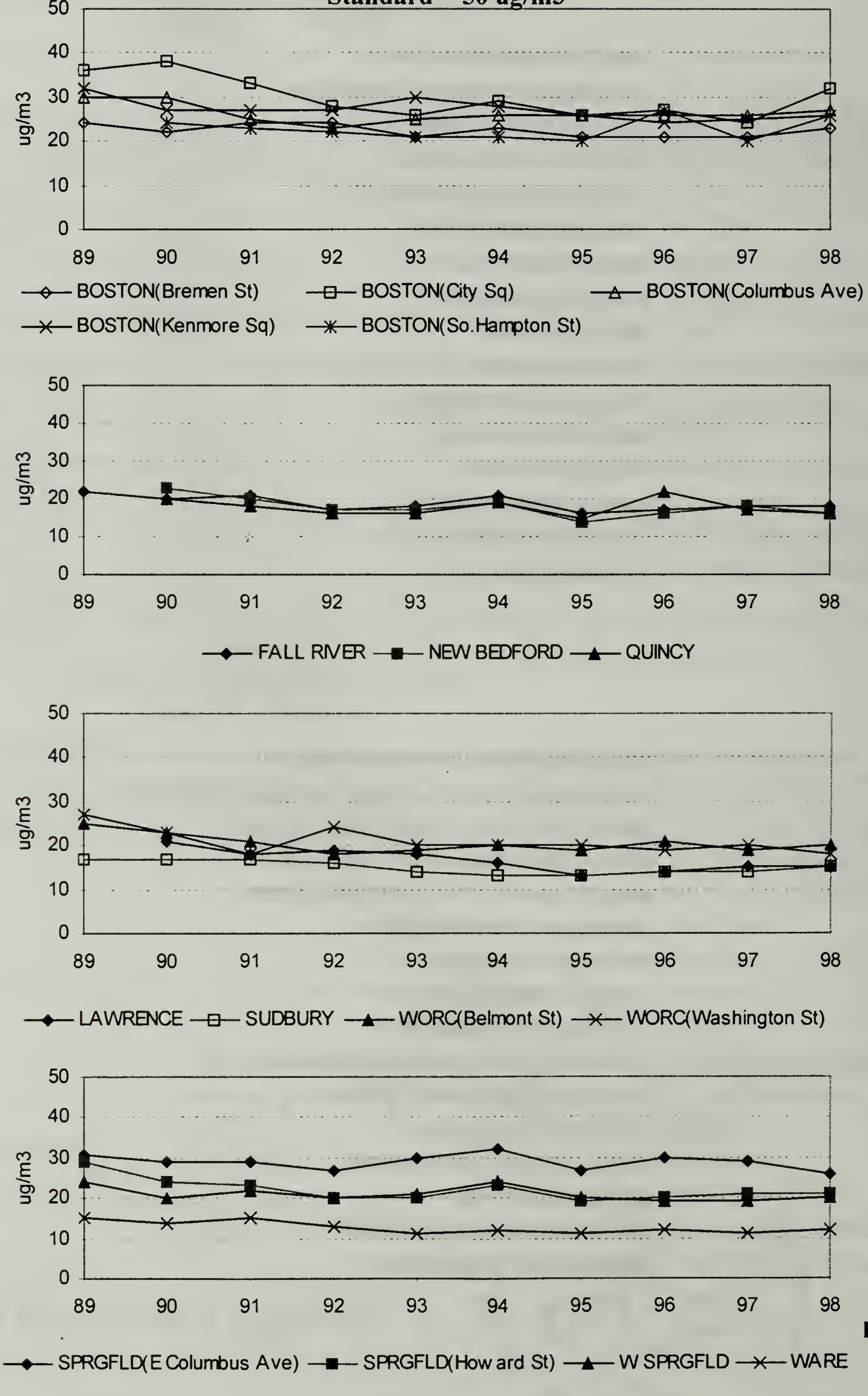


Figure 34

Particulate Matter 2.5-Microns (PM2.5) Summary

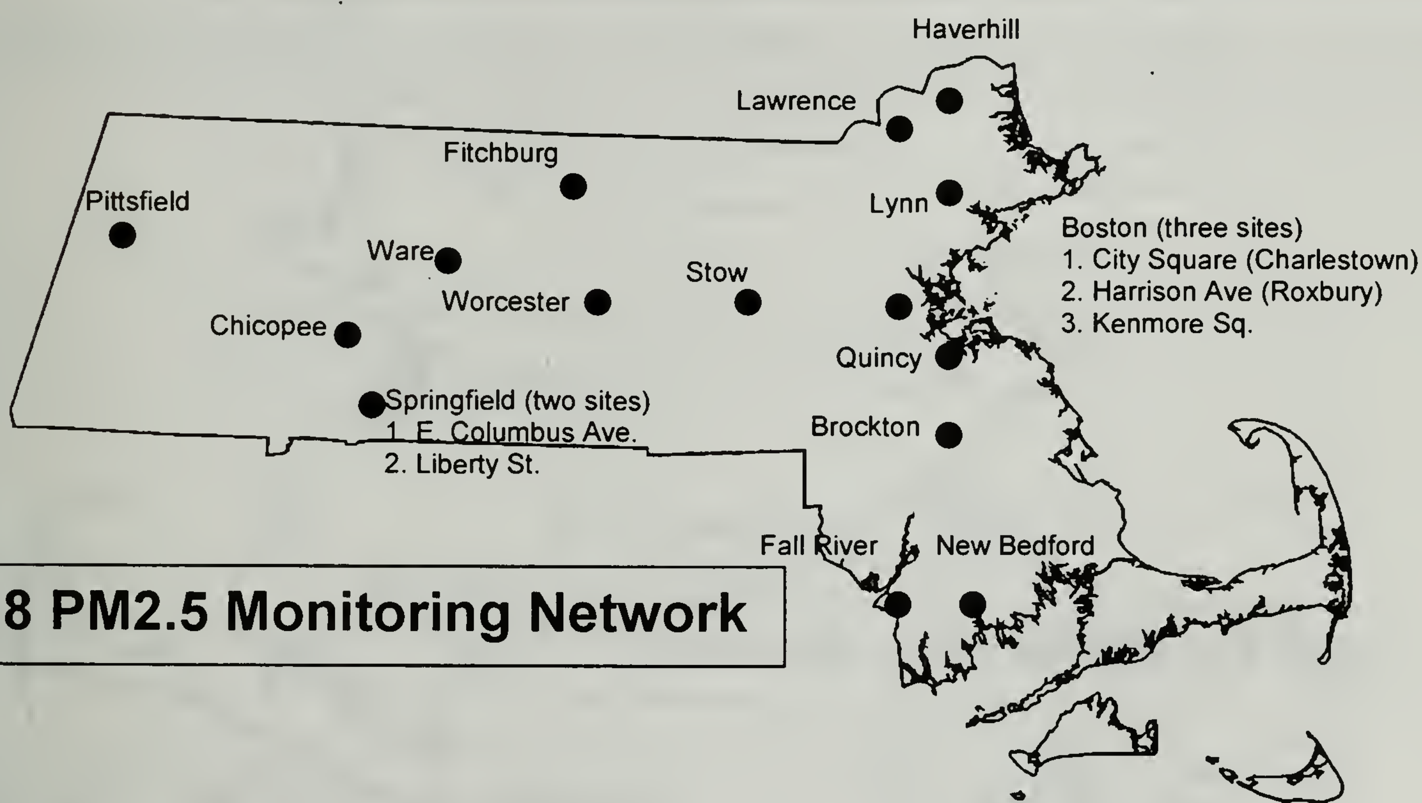
Introduction

The PM2.5 monitoring network was established during November and December 1998. Eighteen sites were established in 15 cities throughout Massachusetts. Preliminary samples were taken to test the monitors and sampling procedures. Data will be reported beginning January 1999.

Why PM2.5 is monitored

In 1997 the USEPA added PM2.5 as a particulate standard, in addition to the PM10 standard. The numbers, 2.5 and 10, refer to the particle size, measured in microns, which are collected by the monitors.

Scientific studies published since 1987 indicate that smaller particles, less than 2.5 microns in diameter, are largely responsible for the health effects of greatest concern, and for visibility impairment (for example, atmospheric haze which obscures scenic views). USEPA estimates that the new standards, along with clean air programs already planned, will reduce premature deaths by about 15,000 a year and serious respiratory problems in children by about 250,000 a year.



1998 PM2.5 Monitoring Network

Lead (Pb) Summary

Introduction

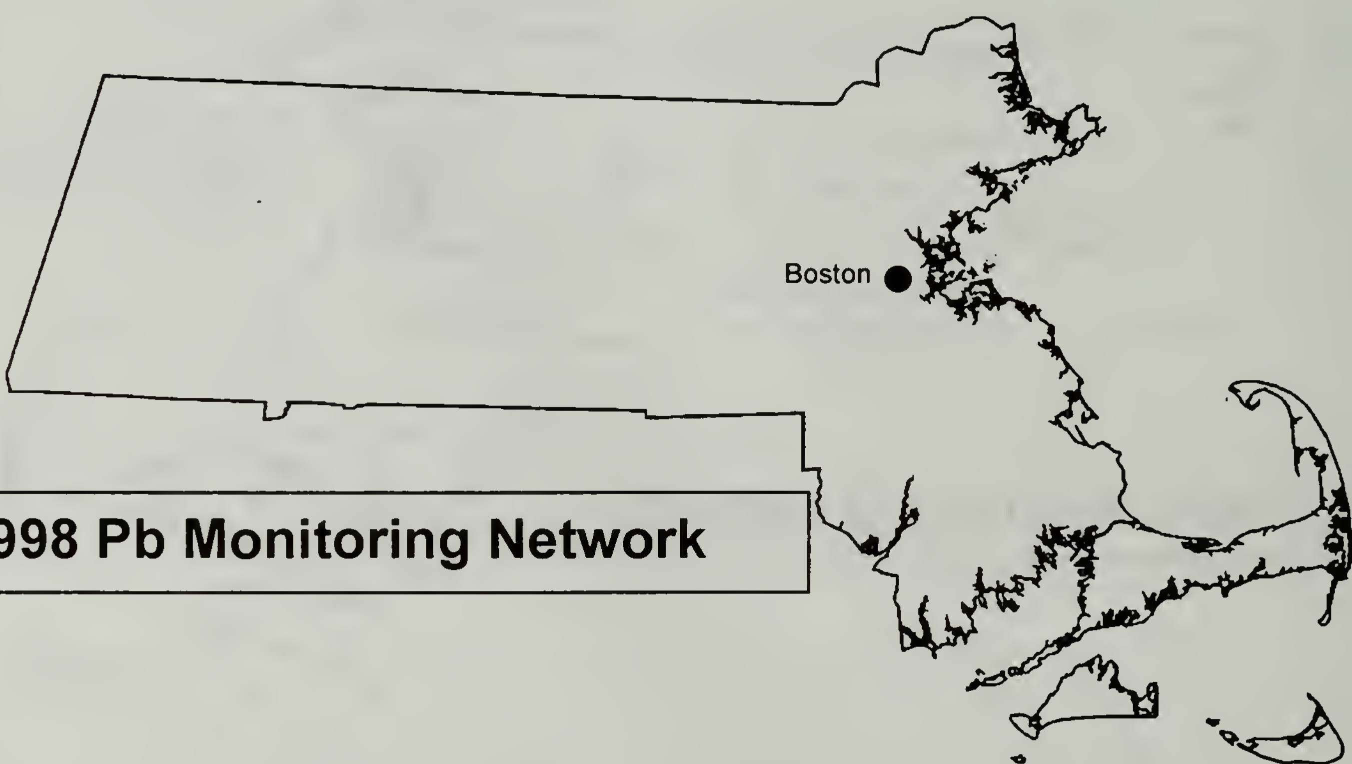
As required by the USEPA, lead monitoring was reinstituted in 1998 after being discontinued in July 1995. The concentrations monitored are very low, since the primary source for airborne lead is motor vehicles and the use of unleaded gasoline has greatly diminished lead emissions. The lead standard is a calendar quarter arithmetic mean of 1.5 ug/m^3.

A summary of the 1998 data is listed below.

	P				UNITS: UG/CU METER								
	O	M				%	-QUARTERLY ARITH MEANS				MEANS	MAX VALUES	
SITE ID	C	T	CITY	COUNTY	ADDRESS	OBS	1ST	2ND	3RD	4TH	>1.5	1ST	2ND
25-025-0002	1	1	BOSTON	SUFFOLK	KENMORE SQ.	67	.02?	.02?	.03	.01	0	.06	.05

? INDICATES THAT THE MEAN DOES NOT SATISFY SUMMARY CRITERIA (NUMBER OF OBSERVATIONS FOR AT LEAST 1 QUARTER < 75%)

ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (2 = SLAMS, 3 = OTHER) **% OBS** = DATA CAPTURE PERCENTAGE **QUARTERLY ARITH MEANS 1ST,2ND,3RD,4TH** = THE MEANS FOR THE 1ST,2ND,3RD AND 4TH CALENDAR QUARTERS **MEANS > 1.5** = THE NUMBER OF CALENDAR QUARTER MEANS GREATER THAN THE STANDARD (1.5 UG/M3) **MAX VALUES 1ST, 2ND** = THE 1ST & 2ND MAXIMUM 24 HOUR VALUES



1998 Pb Monitoring Network

Total Suspended Particulate (TSP) Summary

Introduction

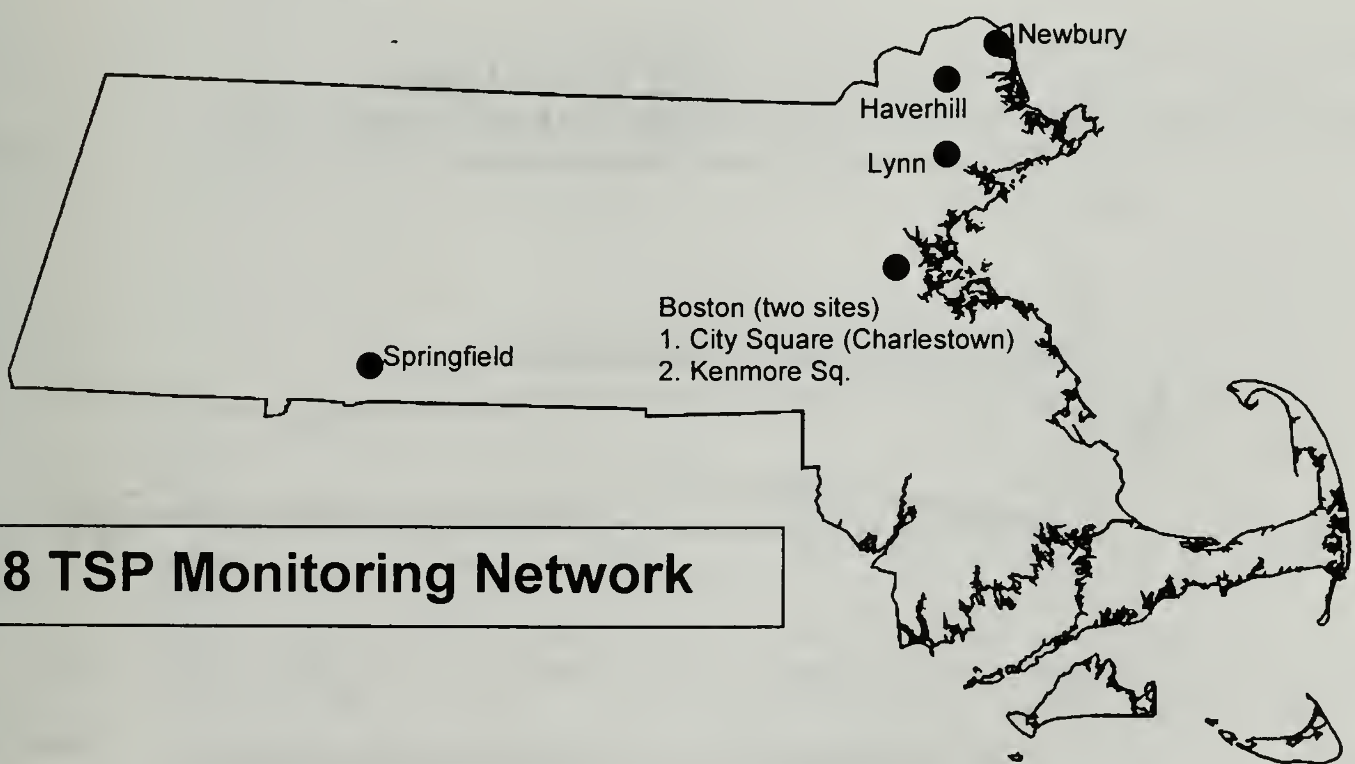
TSP is no longer a criteria pollutant, having been replaced as the particulate air quality standard in 1987 by PM10. The network, which consisted of six sites in 1998, is being reduced in 1999 to one site located in Boston. The Boston site is being maintained to continue monitoring lead emissions.

A summary of the 1998 data is listed below.

SITE ID	POC	MT	CITY	COUNTY	ADDRESS (UNITS: UG/CU METER)	% OBS	MAXIMUM 24-HR VALUES 1ST	2ND	3RD	4TH	ARITH MEAN	GEO MEAN	GEO STD
25-025-0002	1	3	BOSTON	SUFFOLK	KENMORE SQ.	67	126	124	104	93	64?	59?	1.5
25-025-0027	1	2	BOSTON	SUFFOLK	ONE CITY SQUARE	80	203	166	116	115	67?	58?	1.5
25-025-0027	2	3	BOSTON	SUFFOLK	ONE CITY SQUARE	34	111	93	90	82	52?	46?	1.5
25-009-5005	1	3	HAVERHILL	ESSEX	WASHINGTON ST.	54	118	89	53	52	34?	28?	1.9
25-009-2006	1	3	LYNN	ESSEX	390 PARKLAND AVE.	89	90	75	73	55	35?	32?	1.6
25-009-4004	1	3	NEWBURY	ESSEX	SUNSET BOULEVARD	59	103	66	63	48	30?	25?	1.9

? INDICATES THAT THE MEAN DOES NOT SATISFY SUMMARY CRITERIA (NUMBER OF OBSERVATIONS FOR AT LEAST 1 QUARTER < 75%)

ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (2 = SLAMS, 3 = OTHER) **REP ORG** = REPORTING ORGANIZATION **# OBS** = DATA CAPTURE PERCENTAGE **MAXIMUM VALUES 1ST,2ND,3RD,4TH** = 1ST,2ND,3RD AND 4TH HIGHEST 24-HOUR VALUES FOR THE YEAR **ARITH MEAN** = ARITHMETIC MEAN **GEO MEAN** = GEOMETRIC MEAN **GEO STD** = GEOMETRIC STANDARD DEVIATION



1998 TSP Monitoring Network

TSP data summary

TSP is not a criteria pollutant, so there are no standards for it. Figure 35 shows the annual geometric mean and the maximum 24-hour values for 1998. The values are all within the levels of the former standards of 260 ug/m3 (24-hours) and 75 ug/m3 (annual geometric mean). Figure 36 shows the 5-year trend for the annual geometric mean.

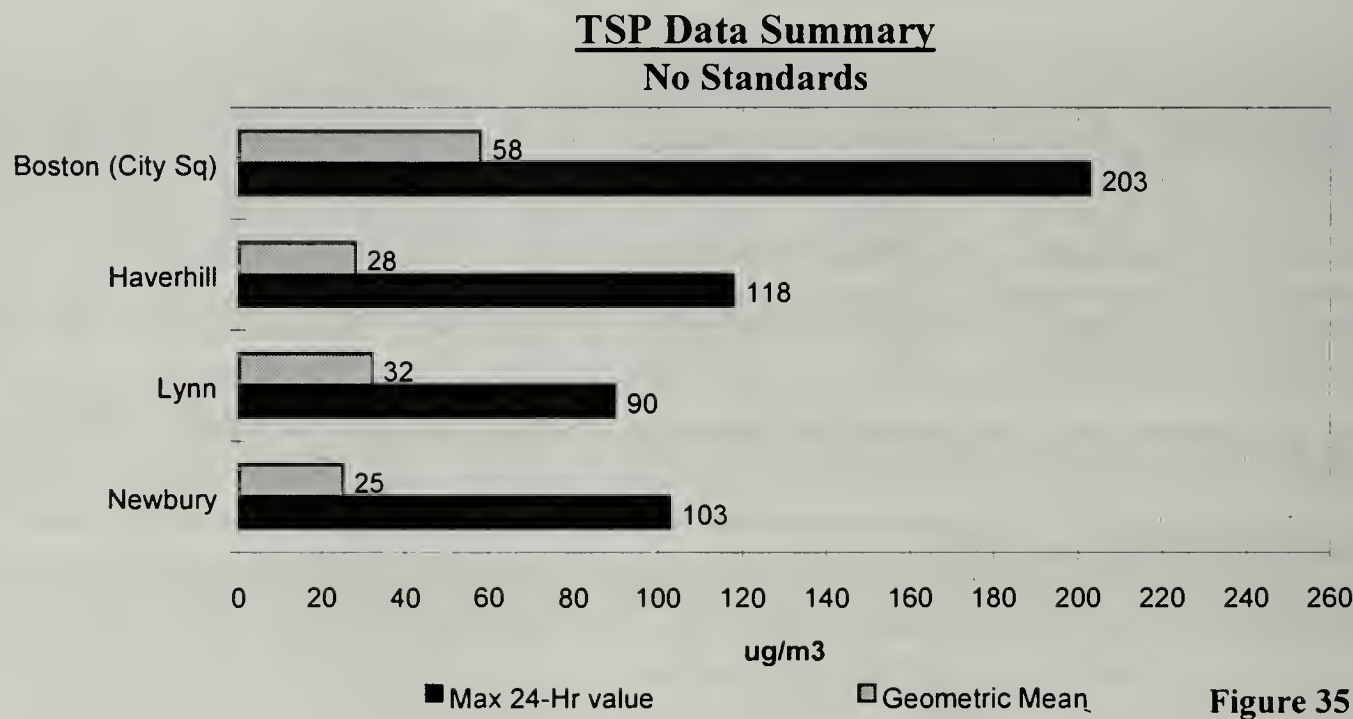


Figure 35

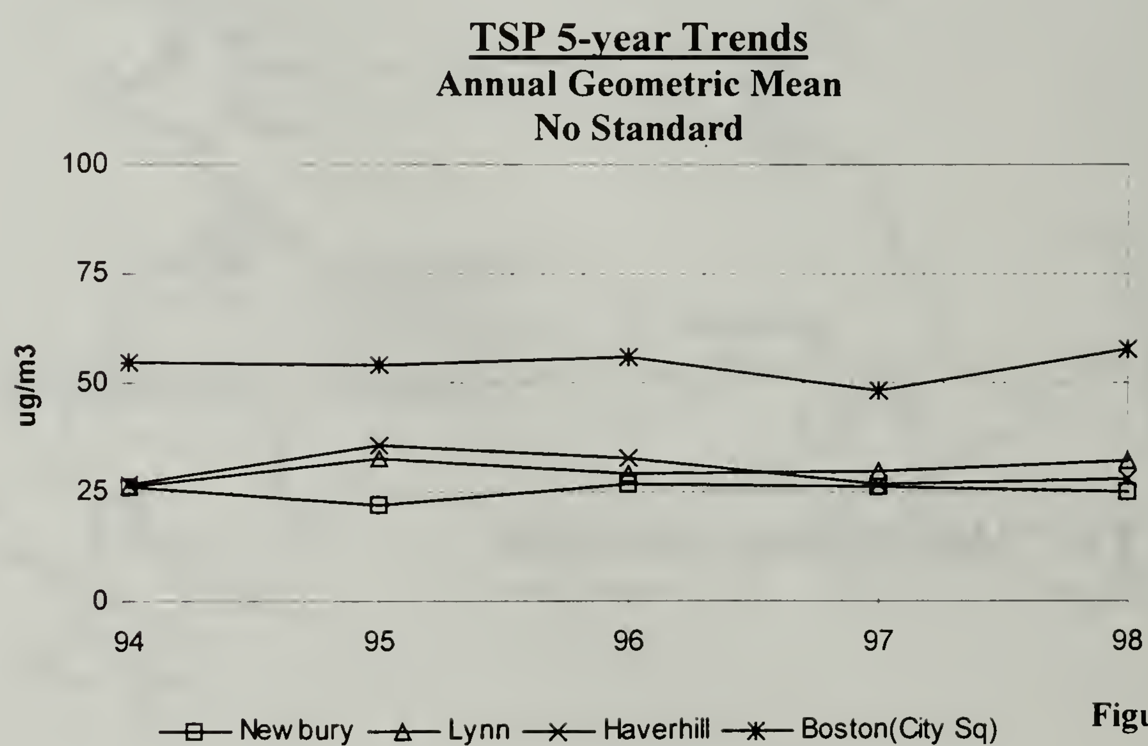


Figure 36

Acid Deposition

What is acid deposition?

Acid deposition occurs when acidic substances fall to the earth's surface from the atmosphere. The emissions of sulfur dioxide (SO2) and the oxides of nitrogen (NOx) react in the atmosphere with water and oxygen to form acidic compounds such as sulfuric acid and nitric acid. These compounds are returned to the earth in precipitation (such as rain, snow or fog), or in dry form as gas and particles.

Effects of acid deposition

Acid deposition causes acidification of surface waters, which jeopardizes the aquatic ecosystem, diminishing and in some cases eradicating fish species. It contributes to forest degradation and also affects soils, which affects the yields of some crops. The formation of the acidic particles in the atmosphere leads to haze and visibility reduction. Acid deposition also is responsible for the corrosion and deterioration of materials and buildings through its effect on stone, metals and paints.

Monitoring in Massachusetts

The MADEP site located in Waltham is part of the National Atmospheric Deposition Program (NADP). The NADP also operates sites in Truro and Ware. The NADP is a cooperative effort that consists of a nationwide network of over 200 precipitation monitoring sites. The NADP has a website at http://nadp.sws.uiuc.edu/.

Precipitation is collected on a weekly basis and sent to a central lab where it is analyzed for compounds including sulfate (SO4), nitrate (NO3), and hydrogen (acidity as pH).

Acid deposition trends

Figure 37 shows the 10-year trend for the pH of precipitation, which is an indicator of acidity. The higher the precipitation pH, the less acidic it is.

Precipitation pH 10-year Trend *

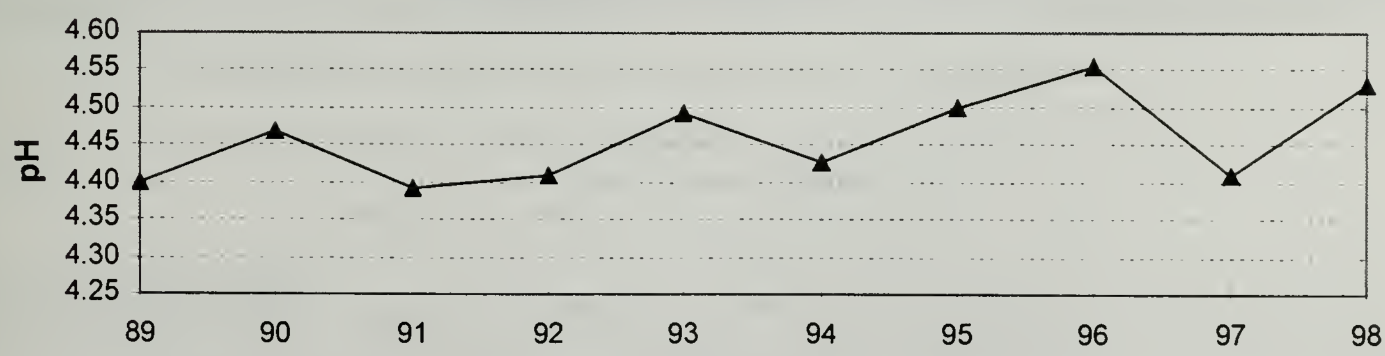


Figure 37

*** data represents the average of the Truro, Waltham and Ware sites**

Continued on next page

Acid deposition trends, Continued

Figure 38 shows the trends for nitrate (NO3) and sulfate (SO4), which result from the emissions of sulfur dioxide (SO2) and oxides of nitrogen (NOx) into the atmosphere. These compounds are harmful to the quality of surface waters. SO4 increases acidity, and NO3 increases acidity and can cause algae blooms.

Nitrate and Sulfate Deposition 10-year Trend *

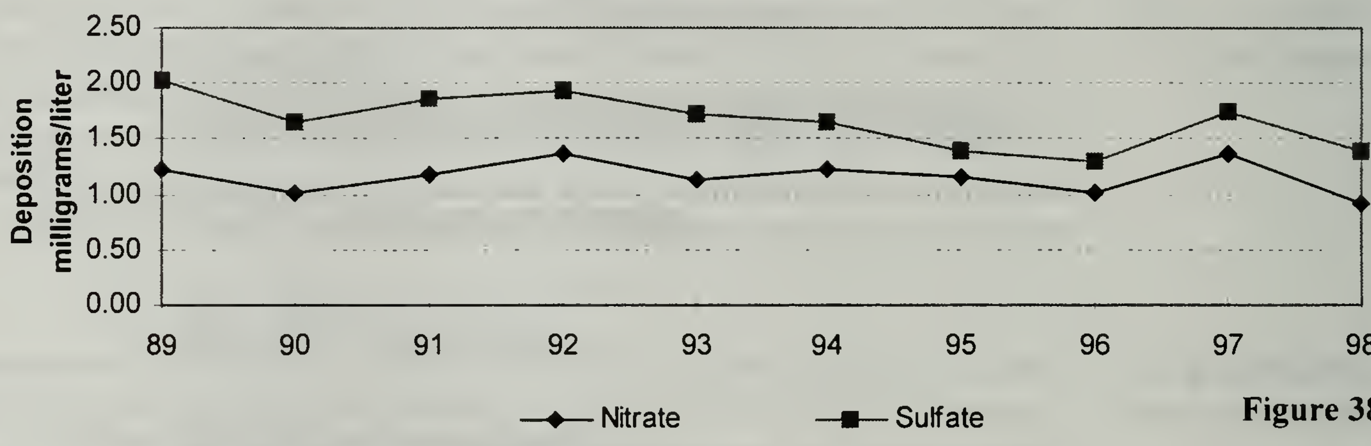


Figure 38

*** data represents the average of the Truro, Waltham, and Ware sites**

Industrial Network Summary

Introduction

The industrial ambient air quality network is comprised of monitoring stations operated by industries with facilities that may potentially emit large amounts of pollutants. An example would be a coal-burning power plant, which emits SO2.

The monitoring stations in the industrial network are sited to measure the maximum values from the specific point source. When the pollutant (SO2) value reaches certain trigger values, the power plant switches to lower sulfur-content fuel.

The data from the industrial network is submitted to the Air Assessment Branch. It is submitted into the USEPA AIRS database after the quality assurance process has been completed.

Sulfur Dioxide (SO2) Summary

There were six SO2 sites during 1998 in the industrial network. All of the sites achieved the requirement of 80% or greater data capture for the year. There were no violations of the SO2 air quality standards during the year.

The highest values were measured at Boston Edison's East First St. site in Boston. The high 24-hour value was 0.040 ppm, which is 29% of the standard; the high 3-hour value was 0.079 ppm which is 16% of the standard; and, the annual arithmetic mean was 0.008 ppm, which is 27% of the standard.

A summary of the 1998 data is listed below.

SITE ID	POC	MT	CITY	COUNTY	ADDRESS (UNITS: PPM)	REP ORG	% OBS	MAX 1ST	24-HR 2ND	MAX 1ST	3-HR 2ND	MAX 1ST	1-HR 2ND	ARIT MEAN
25-025-0019	1	4	BOSTON	SUFFOLK	LONG ISLAND	5	95	.019	.018	.045	.043	.070	.062	.005
25-025-0020	1	4	BOSTON	SUFFOLK	DEWAR STREET	5	95	.025	.023	.060	.060	.069	.067	.006
25-025-0021	2	4	BOSTON	SUFFOLK	340 BREMAN ST.	5	95	.019	.018	.038	.036	.056	.052	.006
25-025-0040	1	4	BOSTON	SUFFOLK	531A E. FIRST ST	5	95	.040	.036	.086	.079	.098	.097	.008
25-009-5004	1	4	HAVERHILL	ESSEX	NETTLE SCHOOL	2	88	.012	.011	.022	.022	.027	.024	.005
25-017-1701	1	4	STONEHAM	MIDDLESEX	HILL STREET	25	90	.025	.024	.066	.066	.125	.085	.007

TO CONVERT UNITS FROM PPM TO mG/M³ MULTIPLY PPM x 2620

PRIMARY STANDARDS: ANNUAL ARITHMETIC MEAN = 0.03 PPM
24-HOUR = 0.14 PPM
SECONDARY STANDARD: 3-HOUR = 0.50 PPM

ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (4 = INDUSTRIAL) **REP ORG** = REPORTING ORGANIZATION **%OBS** = DATA CAPTURE PERCENTAGE **MAX 24-HR, MAX 3-HR, MAX 1-HR 1ST 2ND** = FIRST AND SECOND HIGHEST VALUE FOR TIME PERIOD INDICATED **OBS > .14** = NUMBER OF 24-HR AVG. GREATER THAN 0.14 PPM (24-HR STANDARD) **OBS > .50** = NUMBER OF 3-HR AVG GREATER THAN 0.50 PPM (3-HR STANDARD) **ARIT MEAN** = ARITHMETIC MEAN (STANDARD = 0.030 PPM)

Continued on next page

Nitrogen Dioxide (NO2) Summary

There was one NO2 site during 1998 in the industrial network, operated by Boston Edison in Boston (East First St.). It met the requirement of 80% or greater data capture. There were no violations of the NO2 air quality standard during the year. The annual arithmetic mean was 0.023 ppm which is 43% of the standard.

A summary of the 1998 data is listed below.

SITE ID	POC	MT	CITY	COUNTY	ADDRESS	% OBS	MAX 1-HR 1ST	MAX 1-HR 2ND	ARIT MEAN
					UNITS: PPM				
25-025-0040	1	4	BOSTON	SUFFOLK	531A EAST FIRST ST	94	.092	.082	.023

TO CONVERT UNITS FROM PPM TO uG/M³ MULTIPLY PPM x 1886.8

PRIMARY STANDARD: ANNUAL ARITHMETIC MEAN = 0.053 PPM

ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (4 = INDUSTRIAL) **%OBS** = DATA CAPTURE PERCENTAGE **MAX 1-HR 1ST 2ND** = FIRST AND SECOND HIGHEST VALUE FOR TIME PERIOD INDICATED **ARIT MEAN** = ARITHMETIC MEAN (STANDARD = 0.053 PPM)

Total Suspended Particulates (TSP) Summary

There were four TSP sites during 1998 in the industrial network, all operated by Boston Edison in the city of Boston. All met the requirement of 80% or greater data capture.

TSP is not a criteria pollutant (PM10 replaced it as the particulate standard in 1987), so there is no longer a standard for it. The highest 24-hour value was 108 ug/m3 at the East First St. site, which is 42% of the old standard (260 ug/m3). The highest annual geometric mean was 47 ug/m3 at the Breman St. site, which is 63% of the standard (75 ug/m3).

A summary of the 1998 data is listed below.

SITE ID	POC	MT	CITY	COUNTY	ADDRESS	% OBS	MAXIMUM 24-HR VALUES 1ST	2ND	3RD	4TH	ARITH MEAN	GEO MEAN	GEO STD
					UNITS: UG/CU METER (25C)								
25-025-0019	1	4	BOSTON	SUFFOLK	LONG ISLAND	100	79	53	52	50	30	28	1.5
25-025-0020	1	4	BOSTON	SUFFOLK	DEWAR STREET	100	90	63	60	57	37	35	1.4
25-025-0021	2	4	BOSTON	SUFFOLK	340 BREMAN ST	98	107	105	102	84	50	47	1.4
25-025-0040	1	4	BOSTON	SUFFOLK	531A EAST FIRST STREET	95	108	94	76	73	46	43	1.4
25-025-0040	2	4	BOSTON	SUFFOLK	531A EAST FIRST STREET	98	90	73	72	67	45	43	1.4

ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (4 = INDUSTRIAL) **% OBS** = DATA CAPTURE PERCENTAGE **MAXIMUM VALUES 1ST,2ND,3RD,4TH** = 1ST,2ND,3RD AND 4TH HIGHEST 24-HOUR VALUES FOR THE YEAR **ARITH MEAN** = ARITHMETIC MEAN **GEO MEAN** = GEOMETRIC MEAN **GEO STD** = GEOMETRIC STANDARD DEVIATION

Continued on next page

Sulfate (SO4) Summary

There were four SO4 sites during 1998 in the industrial network, all operated by Boston Edison in the city of Boston. All met the requirement of 80% or greater data capture.

There are no standards for SO4, since it is not a criteria pollutant. The highest 24-hour value, 19 ug/m3, was measured at three sites - Long Island, Dewar St., and Breman St. The highest annual arithmetic mean was 8.17 ug/m3 at Breman St.

A summary of the 1998 data is listed below.

	P				UNITS: UG/CU METER (25C						
	O	M				%	-MAXIMUM VALUES-				ARITH
SITE ID	C	T	CITY	COUNTY	ADDRESS	OBS	1ST	2ND	3RD	4TH	MEAN
25-025-0019	1	4	BOSTON	SUFFOLK	LONG ISLAND	100	19	17	14	12	6.59
25-025-0020	1	4	BOSTON	SUFFOLK	DEWAR STREET	100	19	16	15	13	7.18
25-025-0021	2	4	BOSTON	SUFFOLK	340 BREMAN STREET	98	19	18	17	16	8.17
25-025-0040	1	4	BOSTON	SUFFOLK	531A EAST FIRST STREET	95	18	17	15	13	7.33
25-025-0040	2	4	BOSTON	SUFFOLK	531A EAST FIRST STREET	98	17	16	15	14	7.32

ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (4 = INDUSTRIAL) **% OBS** = DATA CAPTURE PERCENTAGE **MAXIMUM VALUES 1ST,2ND,3RD,4TH** = 1ST,2ND,3RD AND 4TH HIGHEST 24-HOUR VALUES FOR THE YEAR **ARITH MEAN** = ARITHMETIC MEAN

Quality Control and Quality Assurance

Introduction

To ensure that the ambient air quality data is of high quality, MADEP has developed standard operating procedures (SOPs). These procedures include quality control and quality assurance techniques that assess the quality and document the activities performed in collecting the data.

Quality control

Quality control (QC) is comprised of those activities performed by personnel who are directly involved in the generation of the data. Examples of personnel who perform QC functions are site operators and laboratory support personnel. QC activities include calibrations, data validation procedures, and performance checks of the ambient air monitors to assess the precision of the data.

Quality assurance

Quality assurance (QA) is comprised of those activities performed by personnel who are not directly involved in the generation of the data and who may therefore make an unbiased assessment of the data quality. QA activities include performance audit checks of the ambient air monitors to assess the accuracy of the data.

Precision and accuracy

Precision is defined as a measure of the repeatability of a measurement system. Accuracy is defined as a measure of the closeness of an observed measurement value to the defined standard.

The QC and QA performance checks allow the precision and accuracy of ambient air monitors to be quantified. This is done by testing the monitor's response to known inputs in order to assess the measurement error. The QC performance checks assess the precision, while the QA performance checks assess the accuracy.

The requirements and techniques for performing precision and accuracy performance checks are set forth in the Code of Federal Regulations (CFR), Title 40, Part 58, Appendix A.

How precision and accuracy is described

Precision and accuracy are given in the context of upper and lower 95-percentile probability limits for each pollutant parameter. The meaning of the 95-percentile limits is that 95% of the data for a parameter is estimated to be precise or accurate to within the percentage range defined by the upper and lower limits. As an example, if the upper and lower 95-percentile-limits for a parameter based upon precision checks are calculated to be +4.3% and –7.4%, then 95% of the data is precise within the range of +4.3 through –7.4%.

Continued on next page

1998 Precision and accuracy summary

As a goal, the 95-percentile probability limits for precision (all parameters) and PM10 and TSP accuracy should be less than ±15%. The 95 percentile probability limits for accuracy for all other parameters should be less than ±20%. A summary of the data is listed below

							PRECISION DATA				ACCURACY DATA						
PRECISION AND ACCURACY DATA KEY							# OF	PRECIS	PROB	LIM	# AUDITS	PROB	LIM	PROB	LIM	PROB	LIM
RG	ST	RO	TYP	CLASS	POLL	YEAR-Q	ANLYZRS	CHECK	LO	UP	L1-3	LO-L1	-UP	LO-L2	-UP	LO-L3	-UP
01	25	001	C	A	CO	1998	9	214	-10	+11	17	-02	+09	-02	+06	-06	+05
CARBON MONOXIDE						1998-1	9	56	-16	+14	4	+02	+14	+00	+12	-02	+12
						1998-2	9	52	-05	+06	4	-04	+09	+00	+06	-01	+04
						1998-3	9	58	-05	+06	5	-03	+09	-06	+07	-10	+03
						1998-4	9	48	-05	+07	4	+00	+07	-03	+06	-06	+04
01	25	001	C	A	SO2	1998	10	252	-10	+05	20	-11	+09	-12	+09	-13	+08
SULFUR DIOXIDE						1998-1	10	59	-07	+03	7	-08	+12	-07	+12	-07	+13
						1998-2	10	70	-10	+04	3	-05	+03	-06	+03	-08	+03
						1998-3	10	65	-09	+05	5	-09	+10	-11	+10	-13	+08
						1998-4	10	58	-10	+05	5	-18	+03	-17	-01	-17	-06
01	25	001	C	A	NO2	1998	12	298	-12	+11	18	-16	+05	-12	+03	-13	+07
NITROGEN DIOXIDE						1998-1	12	74	-09	+08	6	-16	+09	-14	+04	-17	+10
						1998-2	11	71	-09	+10	4	-11	-06	-14	+03	-13	+04
						1998-3	12	88	-12	+11	4	-17	-03	-15	+00	-11	+00
						1998-4	12	65	-11	+07	4	-07	+00	-04	+02	-06	+05
01	25	001	C	A	O3	1998	16	334	-06	+07	25	-08	+10	-08	+09	-09	+09
OZONE						1998-1	9	57	-04	+07	6	-03	+08	-04	+07	-05	+07
						1998-2	16	102	-06	+06	8	-05	+10	-04	+08	-04	+08
						1998-3	16	104	-05	+05	7	-12	+11	-12	+10	-13	+10
						1998-4	16	71	-06	+07	4	-08	+10	-06	+10	-05	+10
							PRECISION DATA				ACCURACY DATA						
PRECISION AND ACCURACY DATA KEY							# OF	COLLC	PROB	LIM	VAL COLL		#	PROB	LIM	PROB	LIM
RG	ST	RO	TYP	CLASS	POLL	YEAR-Q	SMPLS	SITES	LO	UP	DATA PRS		AUD	LO-L1	-UP	LO-L2	-UP
01	25	001	I	F	TSP	1998	20	1	-35	+20	17		13			-09	+10
SUSPENDED PARTICULATES						1998-1	9	1	-35	+22	6		4			-05	+08
						1998-2	0	0			0		3			-37	+22
						1998-3	9	1	-40	+20	9		2			-04	+05
						1998-4	2	1	-05	+10	2		4			-07	+13
01	25	001	I	F	PM10	1998	112	3	-16	+24	68		52			-07	+12
PM10 TOTAL 0-10UM						1998-1	30	3	-04	+11	19		10			-09	+14
						1998-2	24	3	-04	+11	14		11			-11	+14
						1998-3	27	3	-13	+28	22		17			-10	+12
						1998-4	31	3	-27	+37	13		14			-06	+13
01	25	001	I	F	PM10	1998	112	3	-16	+24	72		52			-07	+11
PM10 LOCAL CONDITIONS						1998-1	30	3	-04	+11	19		10			-11	+14
						1998-2	24	3	-03	+11	14		11			-11	+14
						1998-3	27	3	-14	+28	22		17			-10	+12
						1998-4	31	3	-26	+35	17		14			-06	+13

ABBREVIATIONS AND SYMBOLS USED IN TABLE
RG = EPA REGION **ST** = STATE **RO** = REPORTING ORGANIZATION **TYP** = ANALYZER TYPE (CONTINUOUS OR INTERMITTENT) **CLASS** = ANALYTICAL (A); FLOW (F) **YR** = YEAR **# OF ANLYZRS** = NUMBER OF ANALYZERS **PRECIS CHECKS** = NUMBER OF PRECISION CHECKS **PROB LIM LO/UP** = LOWER AND UPPER 95% PROBABILITY LIMITS **# AUDITS L1-3** = NUMBER OF AUDITS **PROB LIM LO-L1-UP** = LOWER AND UPPER 95% PROBABILITY LIMITS AT LOW RANGE **PROB LIM LO-L2-UP** = LOWER AND UPPER 95% PROBABILITY LIMITS AT MIDDLE RANGE **PROB LIM LO-L3-UP** = LOWER AND UPPER 95% PROBABILITY LIMITS AT HIGH RANGE **# OF SMPLS** =NUMBER OF SAMPLERS **COLLC SITES** = NUMBER OF COLLOCATED SITES **VAL COLL DATA PRS** = NUMBER OF VALID COLLOCATED SAMPLES (ABOVE THE LIMIT USED FOR PRECISION CALCULATION) **# AUD** = NUMBER OF AUDITS

Precision data summary

The figure below presents the precision summary for all parameters for 1998.

1998 Precision Summary

Upper and lower 95% probability limits

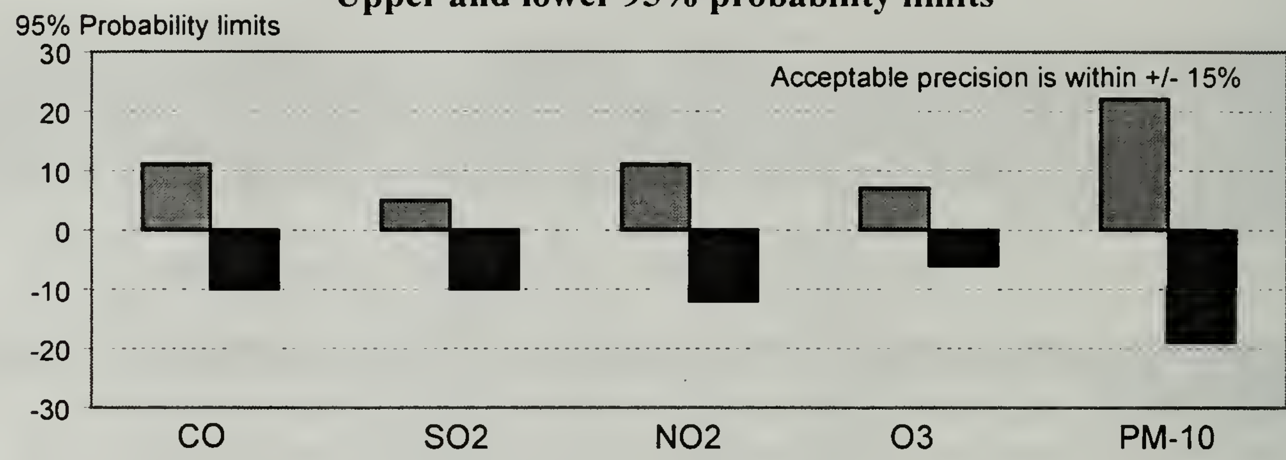


Figure 39

	CO	SO2	NO2	O3	PM10
Upper	+11%	+5%	+11%	+7%	-16%
Lower	-10%	-10%	-12%	-6%	+24%

CO accuracy summary

The figure below presents the CO accuracy summary for 1998.

1998 CO Accuracy Summary

Upper and lower 95% probability limits

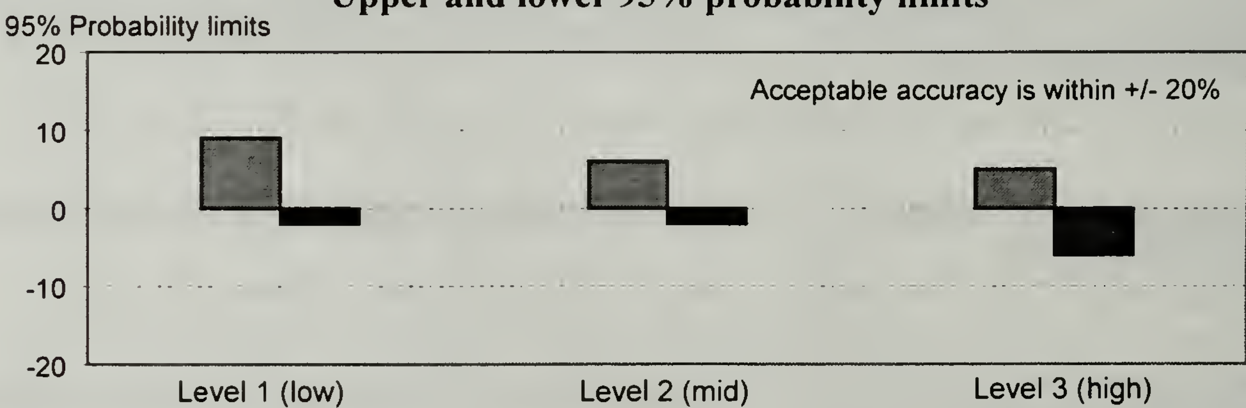


Figure 40

	Level 1 (low)	Level 2 (mid)	Level 3 (high
Upper	+9%	+6%	+5%
Lower	-2%	-2%	-6%

Continued on next page

NO2 accuracy summary

The figure below presents the NO2 accuracy summary for 1998.

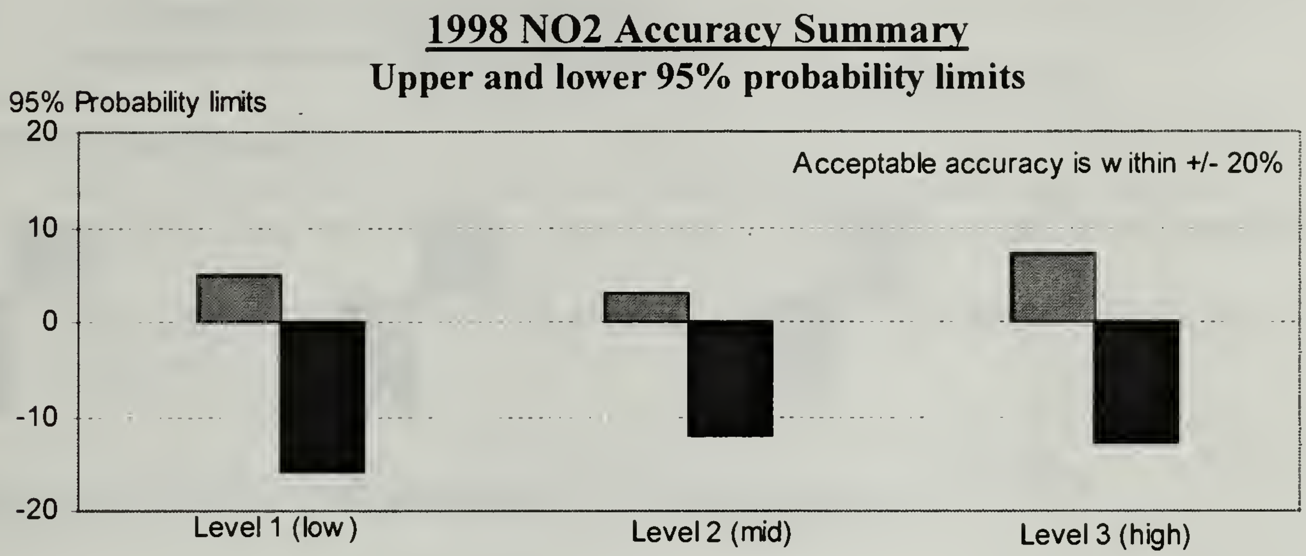


Figure 41

	Level 1 (low)	Level 2 (mid)	Level 3 (high)
Upper	+5%	+3%	+7%
Lower	-16%	-12%	-13%

O3 accuracy summary

The figure below presents the O3 accuracy summary for 1998.

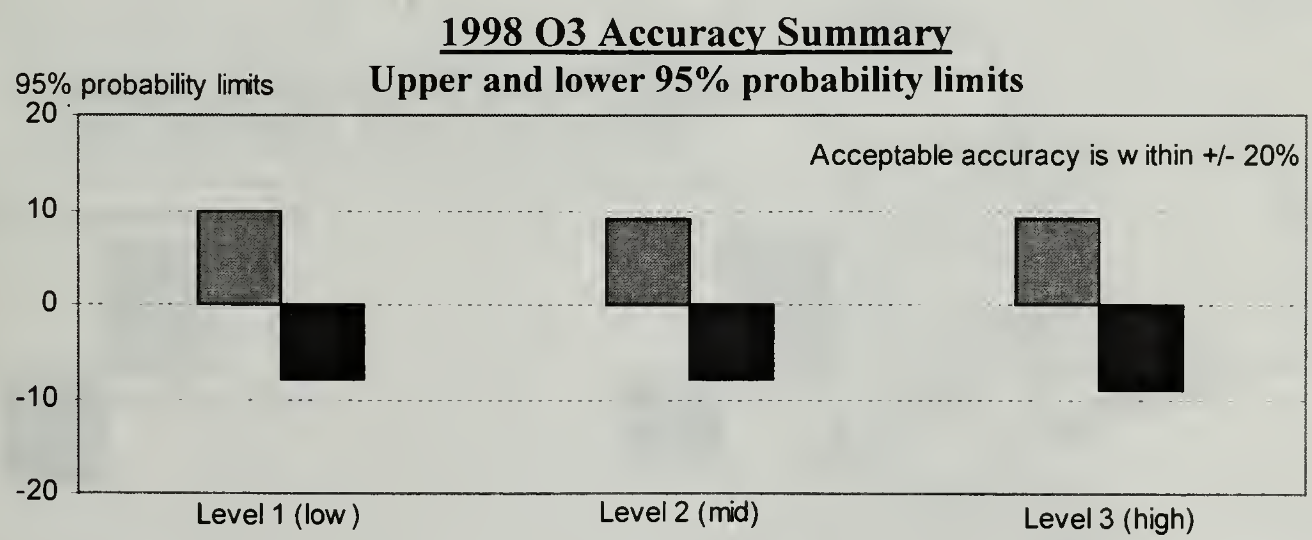


Figure 42

	Level 1 (low)	Level 2 (mid)	Level 3 (high)
Upper	+10%	+9%	+9%
Lower	-8%	-8%	-9%

Continued on next page

SO2 accuracy summary

The figure below presents the SO2 accuracy summary for 1998.

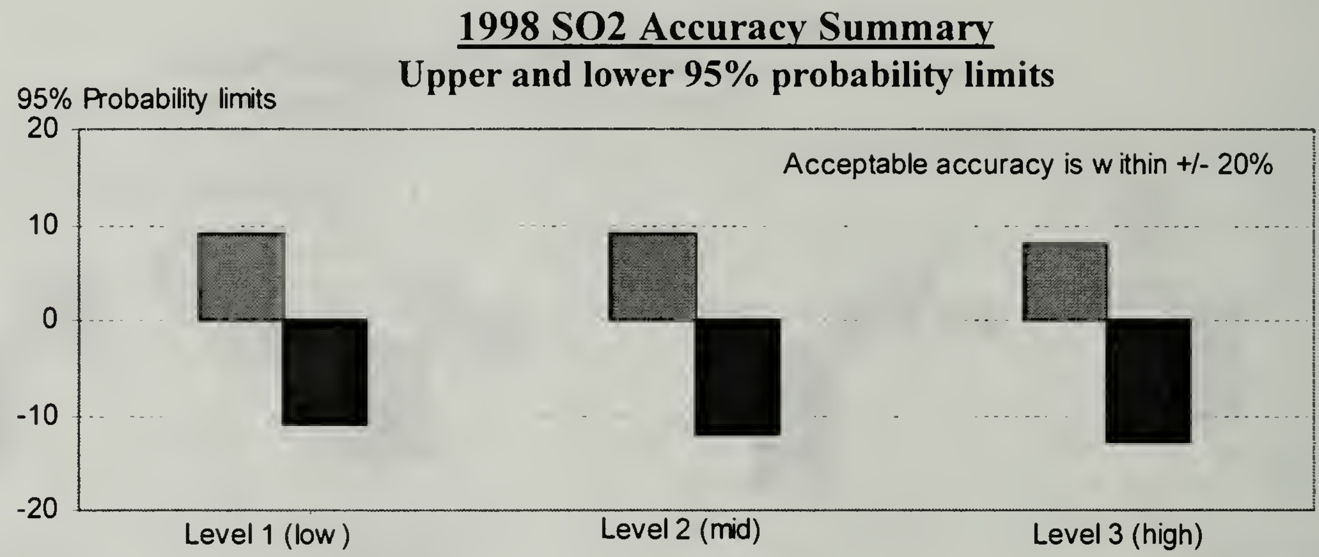


Figure 43

	Level 1 (low)	Level 2 (mid)	Level 3 (high)
Upper	+9%	+9%	+8%
Lower	-11%	-12%	-13%

PM10 and TSP accuracy summary

The figure below presents the PM10 and TSP accuracy summaries for 1998.

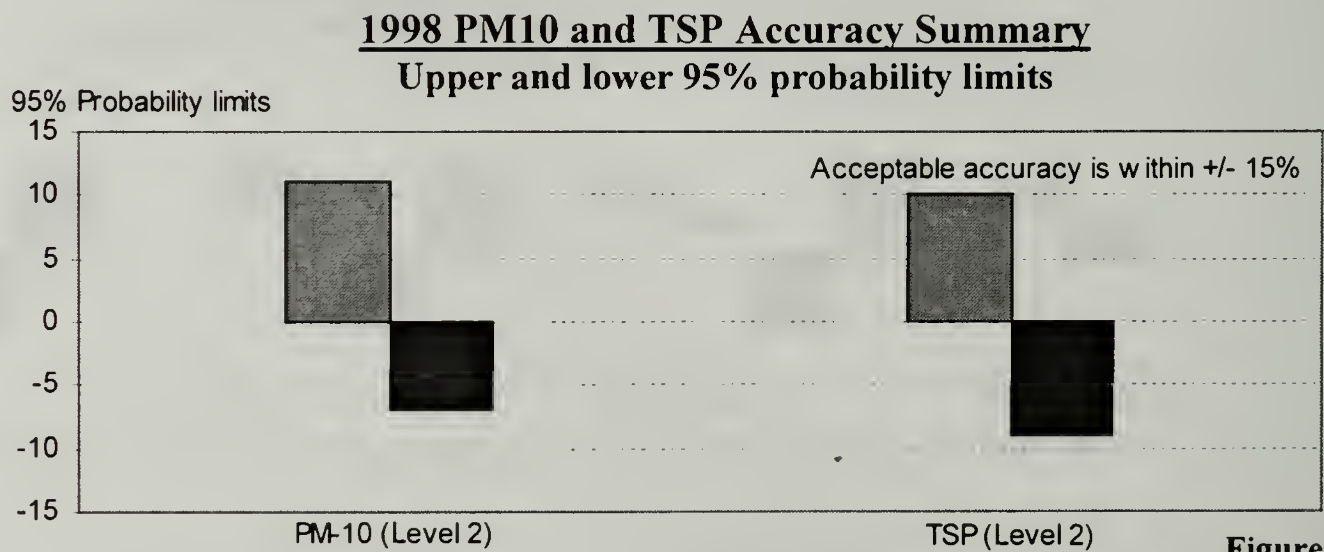


Figure 44

	PM10 (Level 2)	TSP (Level 2)
Upper	+12%	+10%
Lower	-7%	-9%

Air Quality Levels By County

Introduction

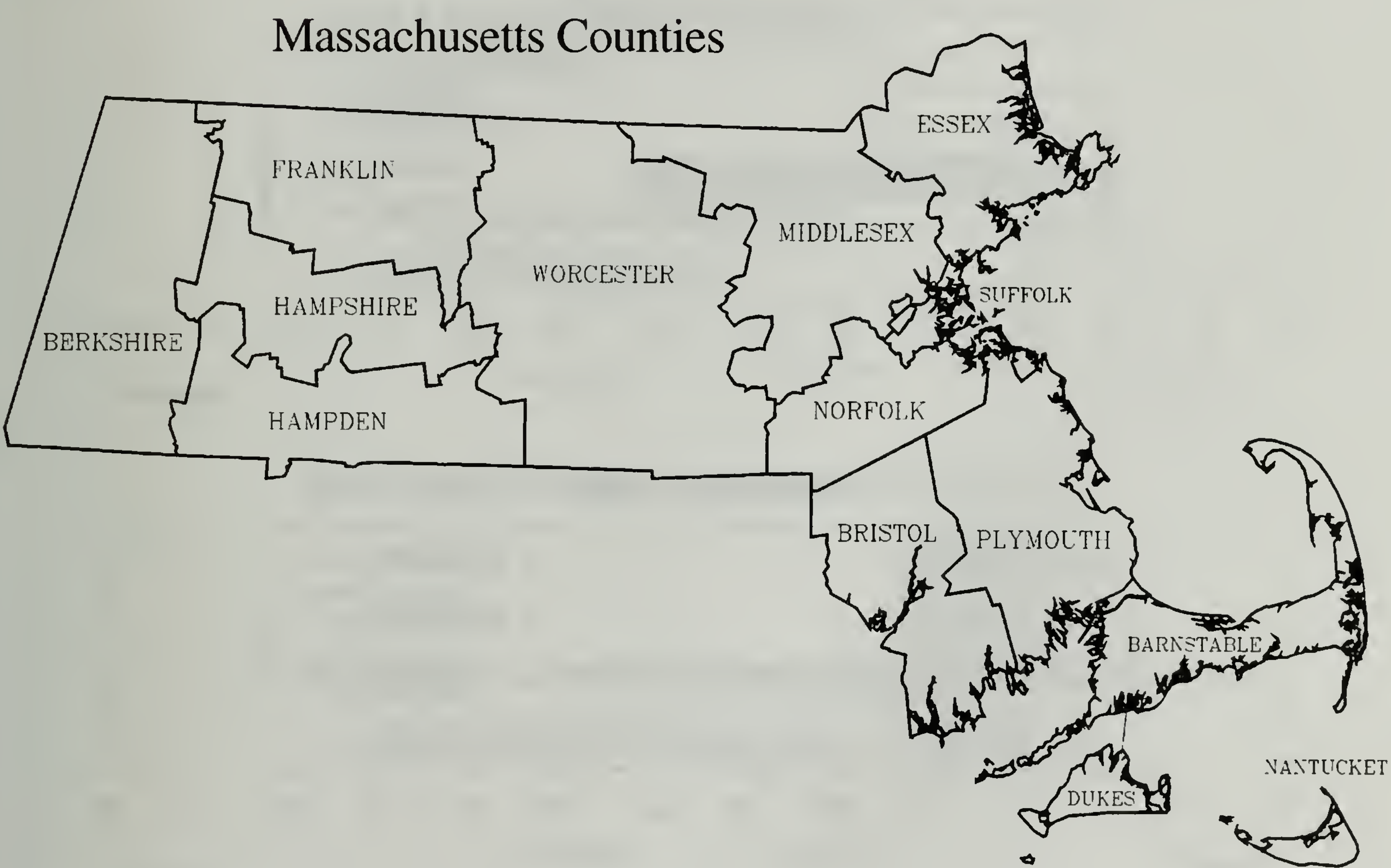
The Pollutant Standards Index (PSI) was developed by USEPA and provides a uniform way of presenting air pollution levels and rating the impact on public health for five major pollutants regulated under the Clean Air Act. The pollutants are ozone (O3), carbon monoxide (CO), sulfur dioxide (SO2), nitrogen dioxide (NO2), and particulate matter 10 microns (PM10).

The PSI value for each parameter represents the annual mean of each day's PSI. Since NO2 does not have a short-term daily federal standard, a PSI value was calculated using the NO2 annual mean and comparing that to the federal standard.

This section shows the annual PSI levels for each county where these pollutants are monitored.

Massachusetts counties

The map below shows the counties in Massachusetts.



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Understanding PSI levels

The PSI level converts the measured concentration of a pollutant to a number on a scale of 0 to 500. A PSI rating of 100 corresponds to the National Ambient Air Quality Standard (NAAQS) for that pollutant. O3 levels are related to the one-hour NAAQS.

The categories of the PSI air quality levels are:

- Good: from 0 to 50
- Moderate: from 50 to 100
- Unhealthful: from 100 to 200
- Very unhealthful: from 200 to 300
- Hazardous: above 300.

PSI levels by county

The figures below present the 1998 PSI levels for the pollutants monitored in each county. The PSI levels are the average for the year of all sites in the county.

Berkshire County Pollutant Levels

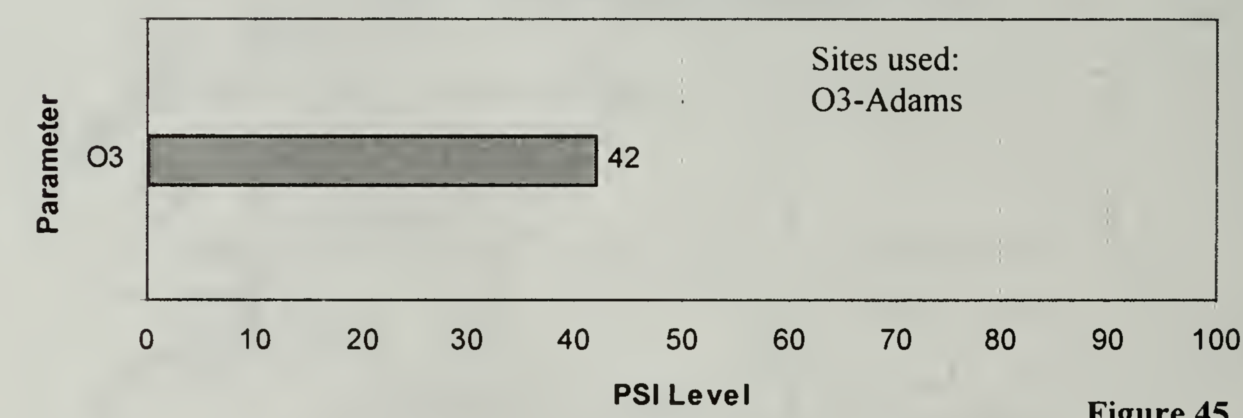


Figure 45

Hampshire County Pollutant Levels

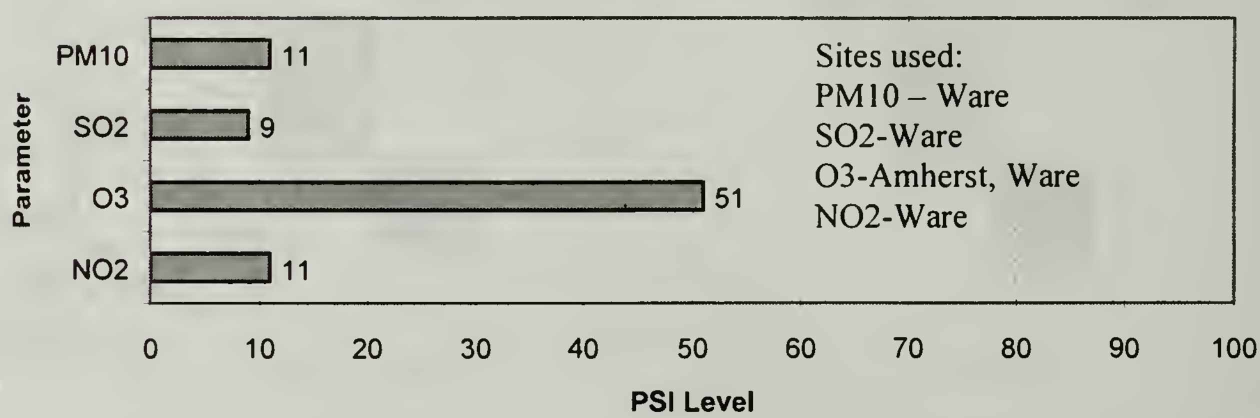


Figure 46

Continued on next page

PSI levels by county, Continued

The figures below present the 1998 PSI levels for the pollutants monitored in each county. The PSI levels are the average for the year of all sites in the county.

Hampden County Pollutant Levels

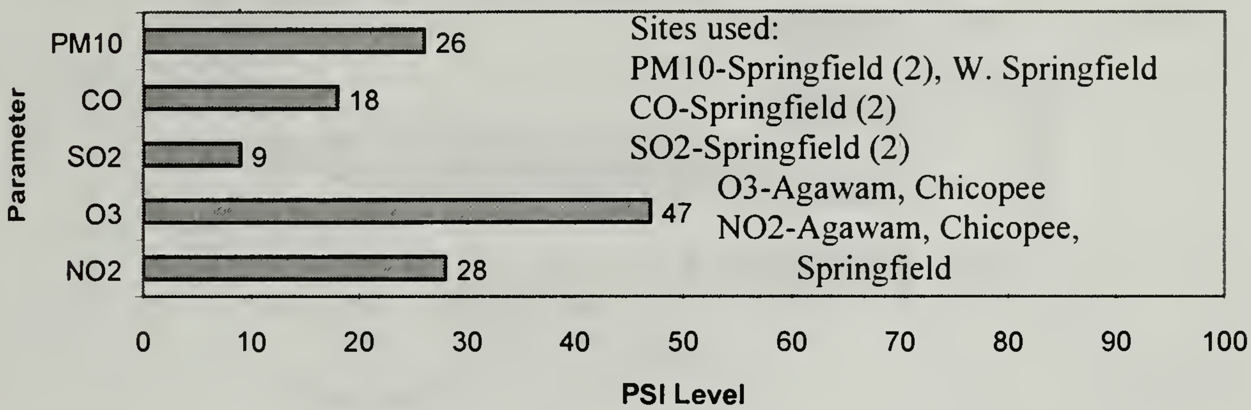


Figure 47

Worcester County Pollutant Levels

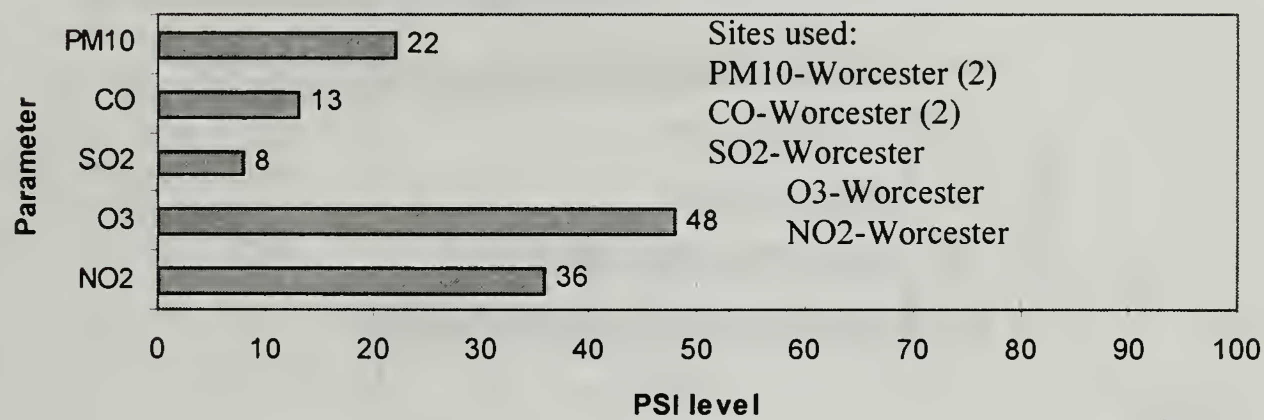


Figure 48

Middlesex County Pollutant Levels

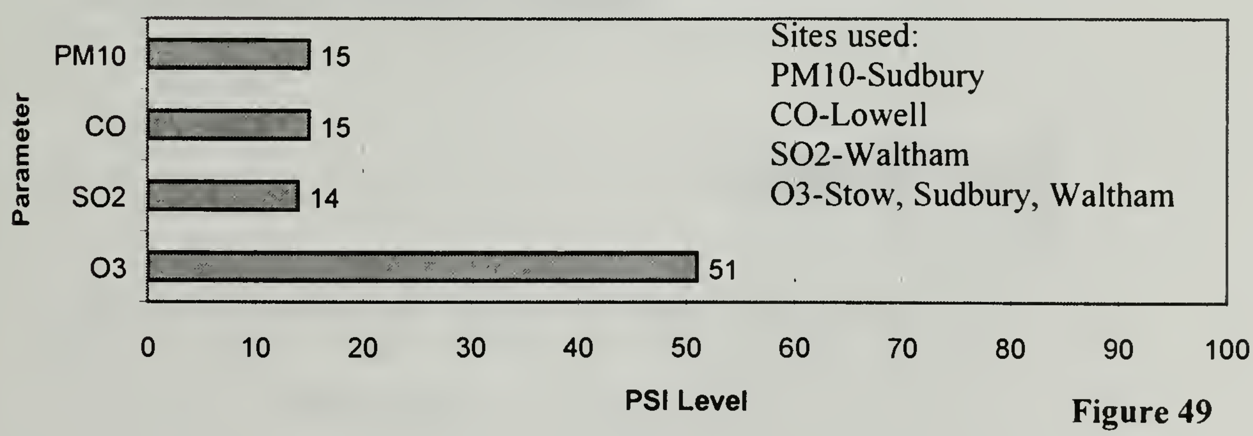


Figure 49

Continued on next page

PSI levels by county, Continued

The figures below present the 1998 PSI levels for the pollutants monitored in each county. The PSI levels are the average for the year of all sites in the county.

Essex County Pollutant Levels

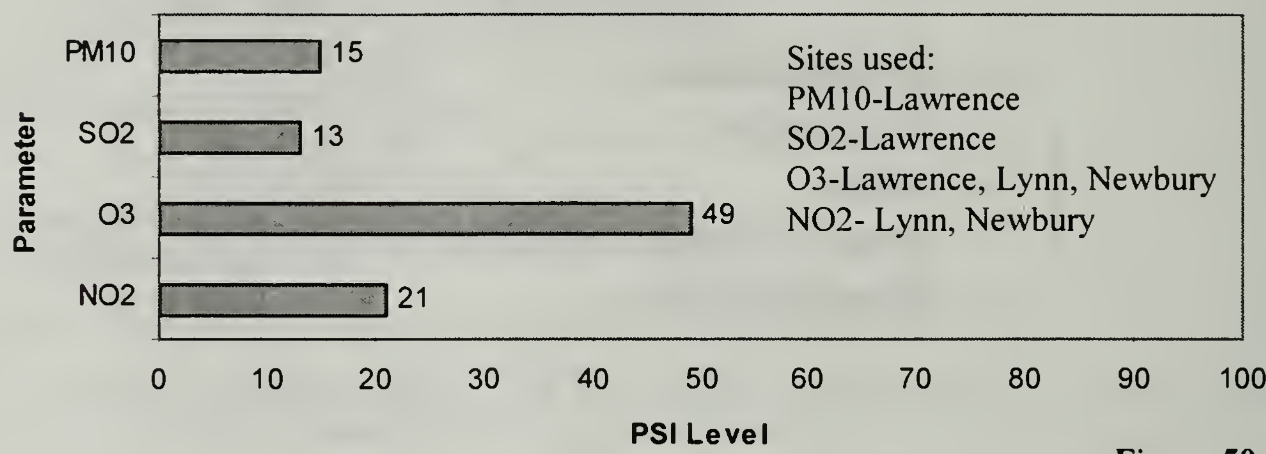


Figure 50

Suffolk County Pollutant Levels

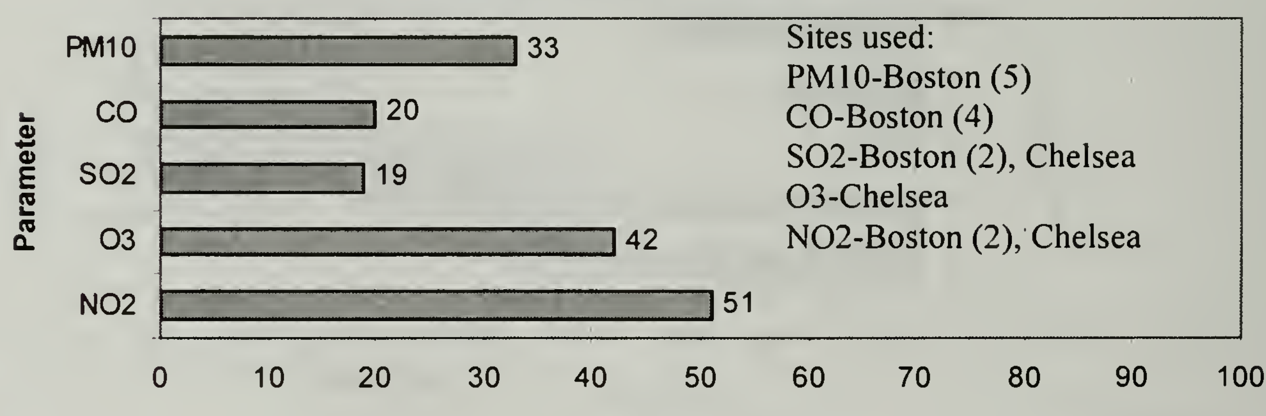


Figure 51

Norfolk County Pollutant Levels

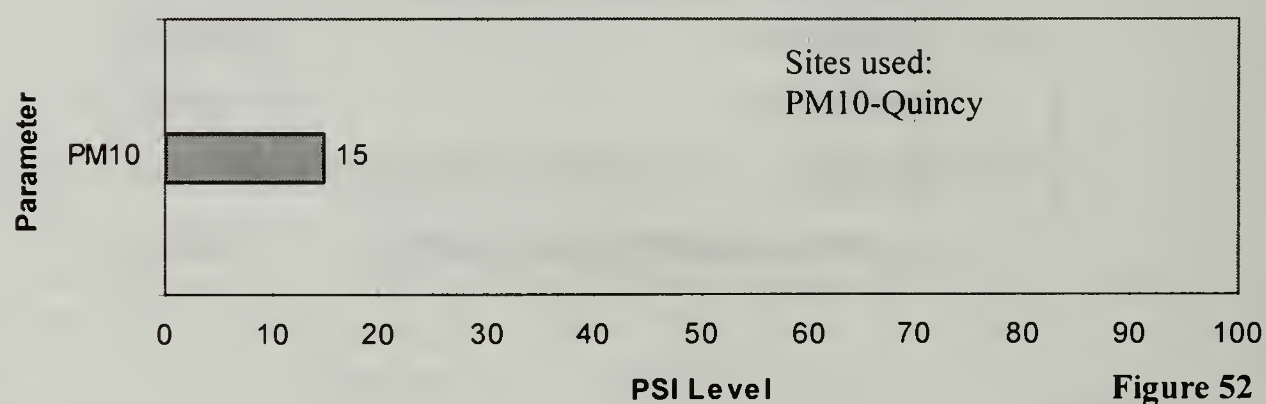


Figure 52

Continued on next page

Air Quality Levels By County, Continued

PSI levels by county, Continued

The figures below present the 1998 PSI levels for the pollutants monitored in each county. The PSI levels are the average for the year of all sites in the county.

Bristol County Pollutant Levels

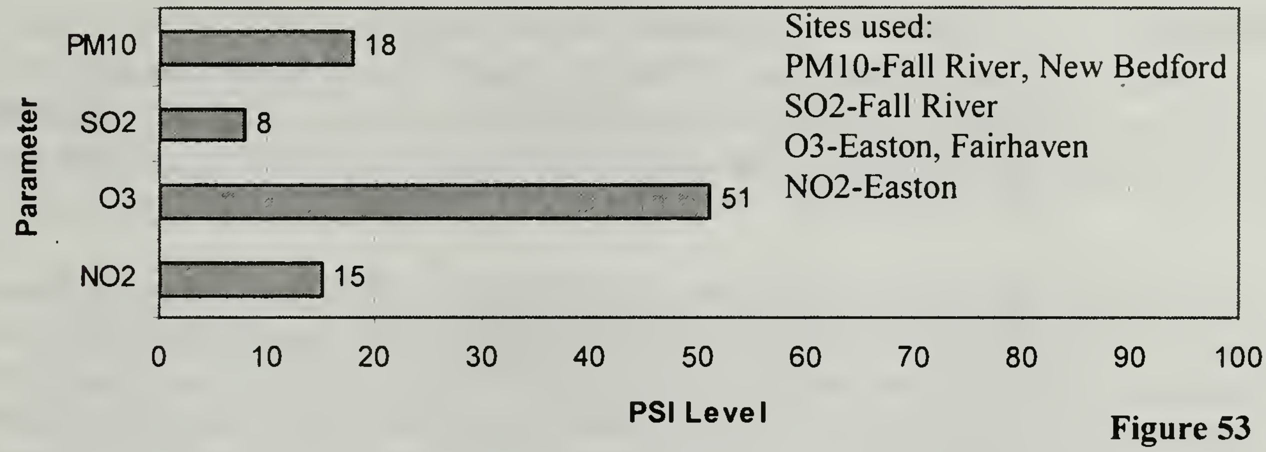


Figure 53

Barnstable County Pollutant Levels

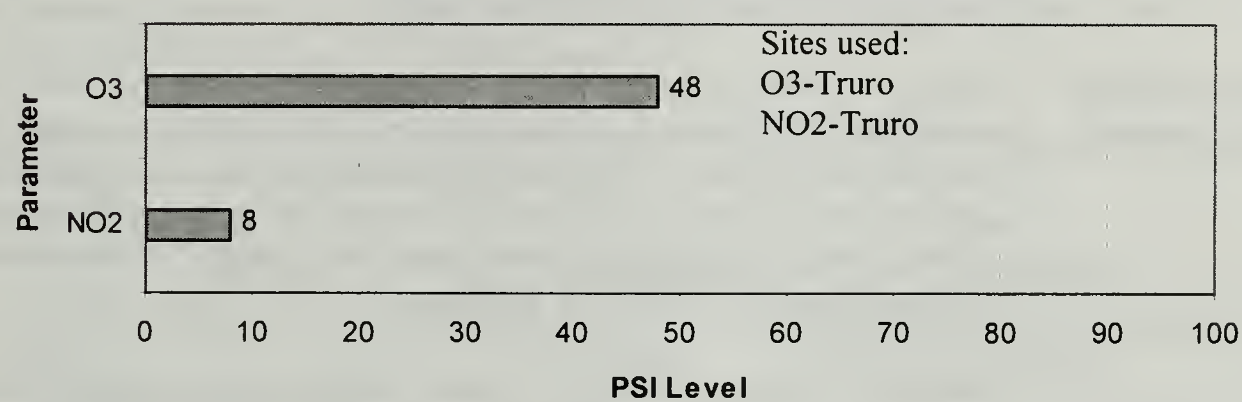


Figure 54

Section IV

PAMS/Air Toxics Monitoring

PAMS Monitoring

Introduction

Non-criteria air pollutants are those pollutants that are monitored in the ambient air for which National Ambient Air Quality Standards (NAAQS) do not exist. This category covers toxic air pollutants (toxic volatile organic compounds [VOCs], semi-volatile organic compounds [SVOCS], toxic elements, and other gases and particles), and ozone precursors and products (PAMS components).

Since 1993, most efforts to monitor non-criteria pollutants have been associated with the PAMS (Photochemical Assessment Monitoring Stations) project. This project, which was mandated by the 1990 Federal Clean Air Act Amendments, requires that state agencies measure a comprehensive list of pollutants and meteorological parameters related to the formation of ozone and other harmful photochemical oxidants during the summer months.

Understanding O3 generation

Ozone, as a harmful pollutant, has been measured since the Clean Air Act was first enacted in 1970. Ozone is unique in that it is formed by reactions between other pollutants in presence of high-energy sunlight, of the intensity found during the summer months. The complexity and subsequent time needed to complete these reactions results in the build up of ground level ozone concentrations far downwind from the original source of the precursors.

Although this complex reaction system had somewhat stymied efforts to reduce summer ozone concentrations to healthy levels, it was well known that oxides of nitrogen and light sensitive (photo-reactive) volatile organic compounds were the major ozone precursors. The PAMS program has been the first consistent effort to measure the ozone precursors, in addition to ozone itself, to gain a better understanding of the chemical reactions that produce ozone.

What is monitored in the PAMS program

Nitrogen oxides and ozone are two criteria pollutant categories also measured as part of the PAMS program. Additionally, two categories of volatile organic compounds (VOCs) must be measured in association with this program. These categories are Hydrocarbons (56 distinct compounds plus unidentified unknowns) and Carbonyls (acetone, acetaldehyde, and formaldehyde).

How are VOCs measured?

The measurement of individual VOC pollutants in ambient air has required the introduction of sophisticated laboratory instruments and techniques, such as gas

Continued on next page

How are VOCs measured?, Continued

and liquid chromatography, into a large scale and routine setting. In fact, laboratory grade gas chromatographs (GCs) take and analyze hourly air samples at four of the seven current operating PAMS sites in Massachusetts during the summer PAMS season months (June, July, and August).

The PAMS monitoring network

The PAMS designated monitoring stations are sited in a southwest to northeast direction around the two cities where PAMS monitoring is required (Boston and Springfield). These sites coincide with wind directions that are prevalent during high ground level ozone events.

Regulations, which were issued subsequent to the passage of the Clean Air Act Amendments, require metropolitan areas to establish a certain number of PAMS sites based upon population. As a result, Springfield is required to have three PAMS sites and Boston is required to have five PAMS sites. The regional scale of the ground level ozone issue has led to one “Boston Area” site being placed in Maine (Acadia National Park); one “Providence Area” site being placed in Massachusetts (Truro - Cape Cod National Seashore); and one site being shared by both Boston and Providence (Easton - Borderland State Park).

Below is a table of PAMS stations which are either located in Massachusetts or are associated with one of our city networks.

Boston	Springfield	Providence
Easton (Borderland State Park)	Agawam	Easton (Borderland State Park)
Lynn	Chicopee	Truro (Cape Cod NS)
Newbury (Plum Island)	Ware	
Boston (Long Island)		
Maine (Acadia NP)		

The different types of PAMS monitoring schedules

USEPA Clean Air Act Regulations dictate the intensity of hydrocarbon and carbonyl monitoring depending on the site’s proximity to the central city. Lynn (Boston) and Chicopee (Springfield) are designated to have the most intensive PAMS related sampling. The types of samples include the following:

- GCs take 1-hour hydrocarbon samples at the Lynn and Newbury sites in eastern Massachusetts, and at Chicopee and Ware in the western part of the state, every day throughout the summer.
- Eight, 3-hour time weighted hydrocarbon canister samples are taken every third day throughout the summer at the Agawam, Easton, and Truro locations.
- Eight, 3-hour time weighted carbonyl samples are taken at the Lynn and Chicopee sites every third day throughout the summer.

Continued on next page

The different types of PAMS monitoring schedules, Continued

Both hydrocarbon canister and carbonyl samples are brought back to the Air Assessment Branch (AAB) headquarters in Lawrence for analysis. All PAMS sites collect ozone, nitrogen oxides, and meteorological data on the same continuous hourly schedule throughout the summer.

A number of PAMS target pollutants, including benzene and formaldehyde, are of concern because of their toxic properties. In addition to the monitoring schedule described above:

- every sixth day, 24-hour time weighted hydrocarbon canister and carbonyl samples are taken at the Lynn and Chicopee sites throughout the year to generated annual averages for some of these health relevant target compounds.
- 24-hour hydrocarbon canister samples at the other fully operating PAMS sites are taken every sixth day during the PAMS season (June, July, and August).

Currently, due to current resource restrictions, only 24-hour (year-round) hydrocarbon canister samples are being taken at the newest Boston area PAMS station at Long Island in Boston Harbor.

Characteristics of PAMS data

During PAMS season, thousands of data points for a large number of parameters are generated. Air quality scientists are most interested in data collected during short periods of high ozone episodes when meteorology, precursor activities, and ozone production can be studied.

Typically, ground level ozone concentrations rise during the morning and afternoon depending on the solar intensity and the transport of ozone produced upwind, and fall as the sun sets and cuts off the reaction energy source. Moreover, concentrations of ozone precursors, such as nitrogen oxides and hydrocarbons emitted from vehicles, rise at rush hour but decline throughout the day as they are consumed in ozone related chemical reactions.

Analyzing the patterns of PAMS data

Air quality scientists can review concentration patterns in data from upwind and down wind locations, estimate how much of the ozone participating compounds are locally produced or transported from upwind, and how those proportions affect locally measured ambient ozone concentrations.

Isoprene is a particularly interesting hydrocarbon, because it is primarily emitted by trees during hot weather and participates in ozone reactions. Isoprene concentrations peak during the part of the day when the sun is hottest, but that peak precedes the peak in ozone because some isoprene is consumed in reactions to form more ozone. Peak isoprene concentrations are higher at heavier forested sampling locations and are very low or nonexistent on cool and cloudy days.

Continued on next page

A look at PAMS data on a high ozone day

The spatial and time relationships between PAMS compounds are studied to better understand their connection with ground level ozone production. The following are graphs of four ozone related pollutants, which were measured on a high ozone day in July 1998 at the three PAMS sites in the Springfield area. Agawam is the upwind site, Chicopee is the central city location (immediately downwind of Springfield), and Ware is the downwind location (where ozone values may be expected to be highest).

Ozone, toluene, nitrogen dioxide, and isoprene are plotted on each graph.

- Toluene is plotted as an example of a petroleum hydrocarbon
- Nitrogen dioxide is plotted as the primary reactive oxide of nitrogen
- Isoprene is plotted in contrast to toluene, as a biogenically (i.e. trees) emitted hydrocarbon.

The Chicopee data is shown below. Toluene and nitrogen dioxide, as pollutants associated with vehicles, are expected to be highest at the city-oriented site in Chicopee. Toluene values peak during rush hours when traffic is highest. Also notice that the ozone peaks a few hours past the hydrocarbon peaks, after the chemicals have had time to react.

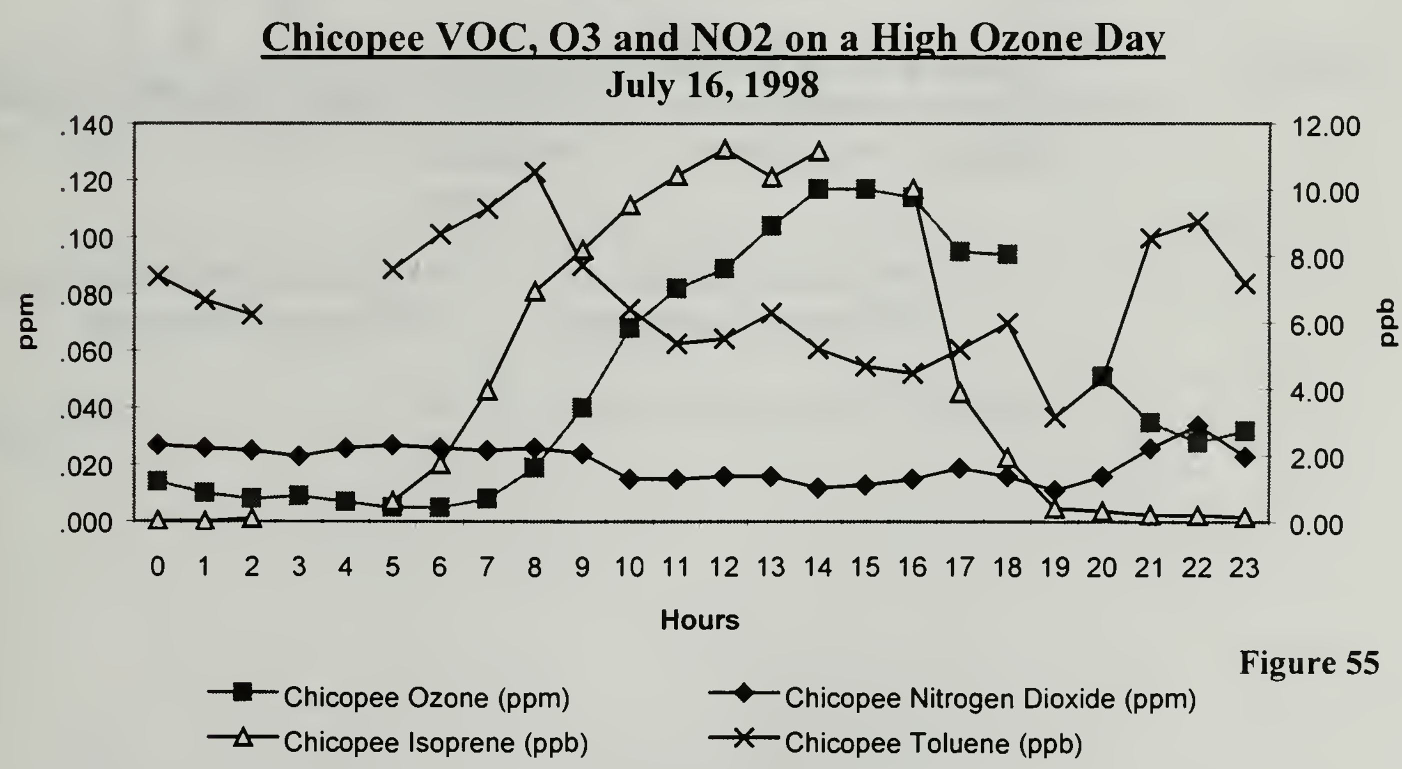


Figure 55

Continued on next page

A look at PAMS data on a high ozone day, Continued

The next two figures show the data from Ware and Agawam.

The structure of the ozone peak becomes more complex at the downwind site (Ware) when compared to the upwind location (Agawam) because locally produced ozone mixes with ozone transported into the region and forms two offsetting components to the peak.

The Ware station consistently records high isoprene levels because of its location at the Quabbin Reservation, which is heavily forested. Ware is a good example of the biogenics (isoprene) curve following the diurnal temperature pattern.

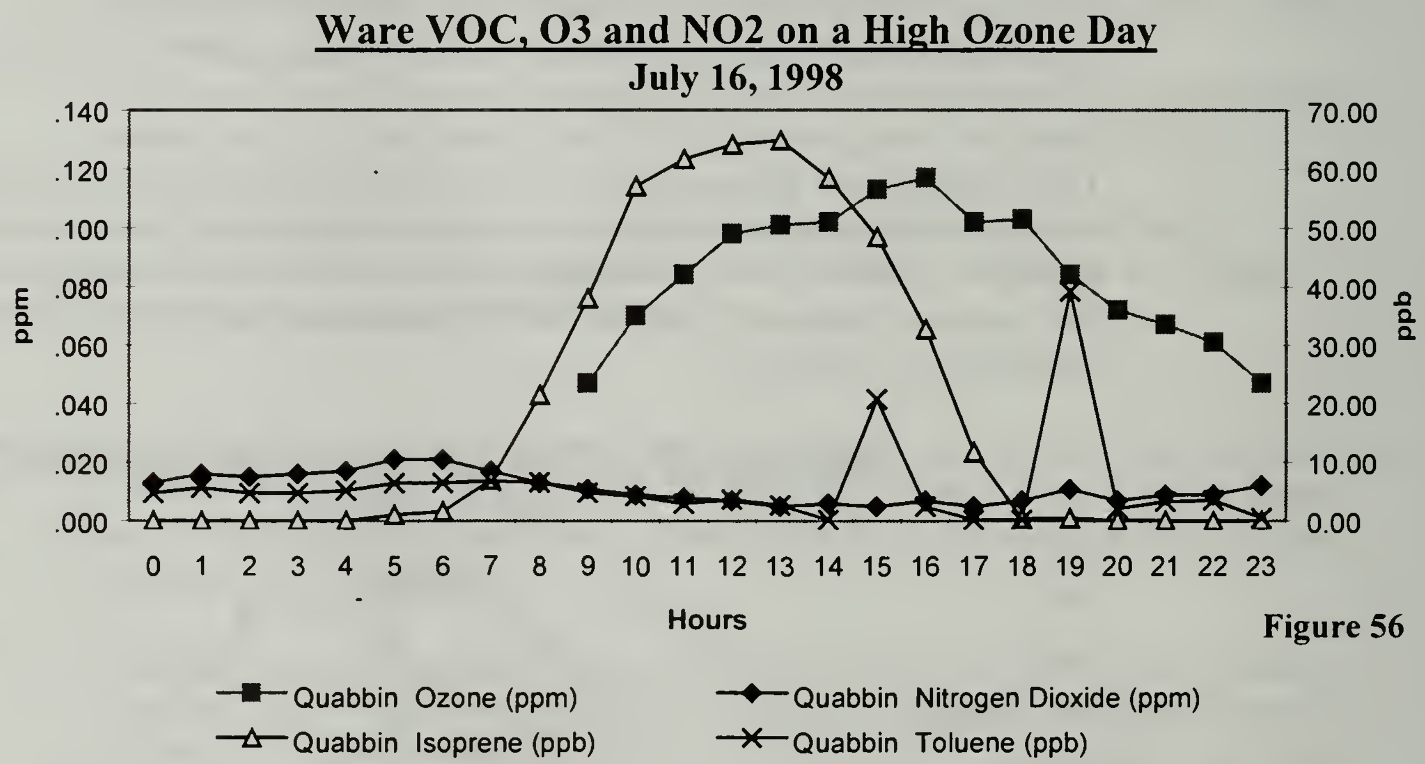


Figure 56

Continued on next page

A look at PAMS data on a high ozone day, Continued

Figure 57 shows that the ozone peaks at Agawam follow the same pattern as at Ware. The ozone peaks occur a few hours after the peaks in the hydrocarbons, allowing for the reaction time of the nitrogen oxides and hydrocarbons.

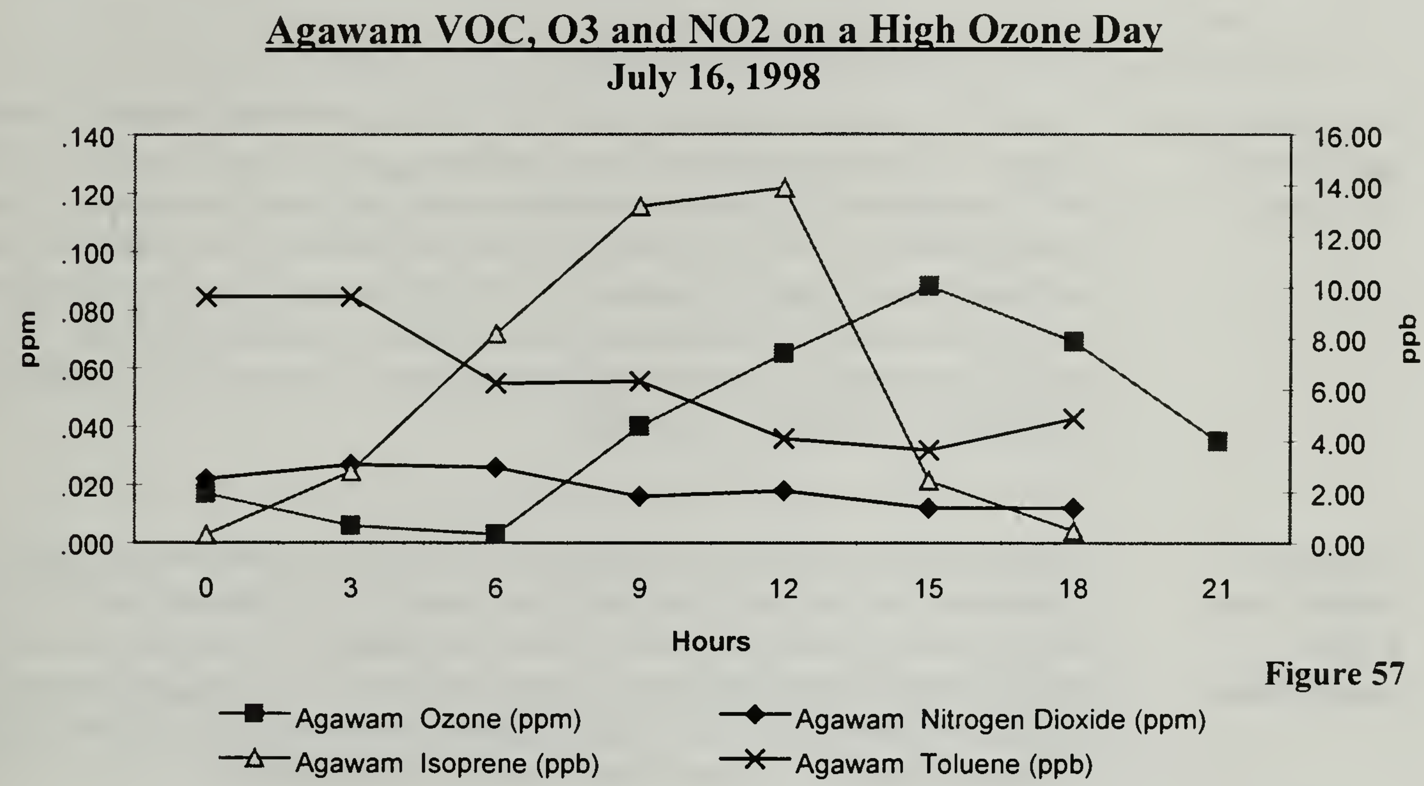


Figure 57

Air Toxics Monitoring

Introduction

Toxic air pollutants usually refer to chemicals that are capable of causing long-term health effects and include volatile and semi-volatile organic compounds, toxic elements, and toxic minerals. Over the last fifteen years, the Air Assessment Branch has been involved with short term, site specific monitoring studies for toxic air pollutants, and has reviewed and commented on plans and results from such studies that have been conducted by private contractors for MADEP.

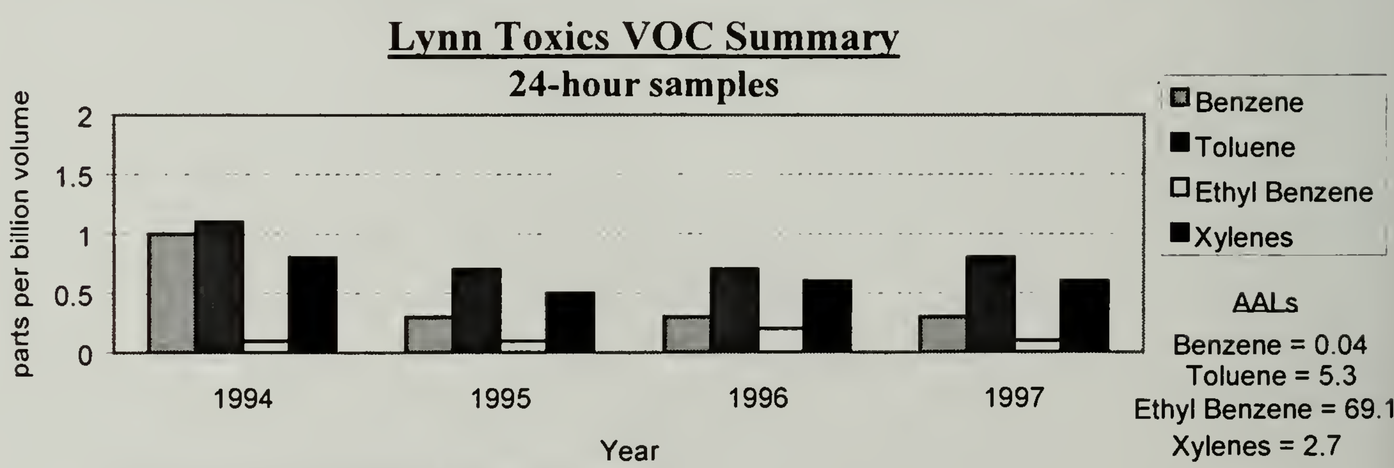
A new air toxics monitoring program

Recently, nationwide discussions have been held to revive efforts to monitor toxic air pollutants at representative ambient locations on a routine schedule. Starting October 1999, a program will begin to take every sixth day canister samples at the new Long Island (Boston Harbor) and Roxbury sites. These weekly samples will be shipped to the Rhode Island State Department of Health Laboratory for gas chromatograph-mass spectrometer (GC-MS) analysis according to USEPA Method TO-15. This analysis determines concentrations of a number of target toxic volatile organic compounds in ambient air samples.

Air toxics results from PAMS monitoring

As described in the above PAMS Section, MADEP collects every sixth day 24-hour hydrocarbon and carbonyl samples year round at the Chicopee and Lynn sites. From the hydrocarbon analyses, values for several health relevant compounds (benzene, toluene, and xylene) proposed to be on the EPA air toxics target list can be extracted from the PAMS results. Two other proposed toxics target chemicals (formaldehyde and acetaldehyde) are target PAMS carbonyl compounds.

Below is a chart summarizing concentrations of 24-hour health relevant PAMS target compounds for samples taken at the Lynn PAMS site from 1994 through 1997. The 1998 data is not yet available. Ethyl benzene is a related compound that does not appear on the USEPA proposed air toxics target list. The benzene concentration decreased, likely the result of the use of reformulated gas beginning in 1995.



AALs = Acceptable Ambient Limits

Figure 58

Continued on next page

Mercury sampling

During 1998, a year long pilot ambient mercury sampling program was concluded at the Ware site. This site was one of several participating locations in New England where 24-hour mercury vapor and particulate samples were taken every sixth day for one year. These samples were sent to the University of Michigan for analysis. A final report on the ambient air phase of the study is expected in early 2000.

The program also included a two year wet deposition component (due to be completed in 1999) to determine mercury concentrations in rainwater in the New England Region.

Section V

Emissions Inventory

Emissions Inventories: 1990–1996

Introduction

This section presents the emission trends for four major pollutants of concern: volatile organic compounds (VOC), nitrogen oxides (NOx), sulfur dioxide (SO2), and carbon monoxide (CO). Emissions data are not available for particulates and lead. The emissions trends cover the period 1990 to 1996.

Reporting emission inventories

The emissions inventories are required to be reported to the USEPA through the State Implementation Plan (SIP) because Massachusetts is non-attainment for the ozone (O3) and CO national air quality standards. The O3 SIP describes the estimated emissions of and control measures for VOC and NOx, since these "O3 precursors" produce O3 in reaction with sunlight under the right conditions. The 1990 SIP included a base year emissions inventory for VOC, NOx, and CO, from which air pollution control programs were developed.

Emissions inventories are required by USEPA every three years. The basic emission methodology involves multiplying an activity factor by an emission factor. MADEP uses a wide range of activity factors such as fuel types, employment, vehicle miles traveled, and population. Emissions factors and methodology are provided by USEPA. MADEP spatially adjusts the emissions to counties and seasonally adjusts them for the summer.

The emissions estimates for the years 1990, 1993, and projected 1996 emissions were submitted to USEPA as part of the SIP process. The 1996 VOC, NOx, and CO emissions estimates presented here were derived from the Draft 1996 Periodic Emissions Inventories which will be available for public comment in fall 1999.

The State Acid Rain (STAR) program

SO2 emissions are tracked annually by MADEP because of the requirements of the 1985 State Acid Rain (STAR) program. The STAR program was implemented to control emissions that cause acid deposition, which is harmful to the environment. The STAR program is more stringent than the federal Acid Rain Program because it imposes a SO2 emissions cap. The 412,000 ton state cap is based upon the average annual SO2 emissions during the four-year base period of 1979–1982. MADEP is required to implement additional control measures if the SO2 cap is exceeded, which has not occurred since the inception of the STAR program.

Continued on next page

Point source emissions trends

The point source category of the emissions inventory comprises the large industrial facilities. This is the only category in which actual data is available for all seven years because of USEPA annual reporting requirements. Figures 59 and 60 show that point source emissions during the 1990-1996 period of VOC, SO2, and NOx have decreased substantially, while CO has increased slightly.

The electric utility emissions are presented in Figure 61 and decreased substantially for the period. Electric utilities comprise the major proportion of NOx and SO2 point source emissions.

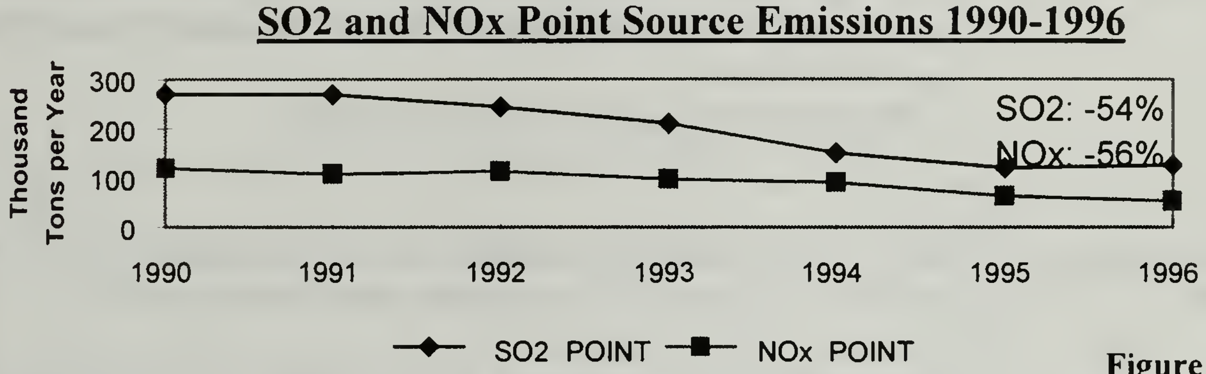


Figure 59

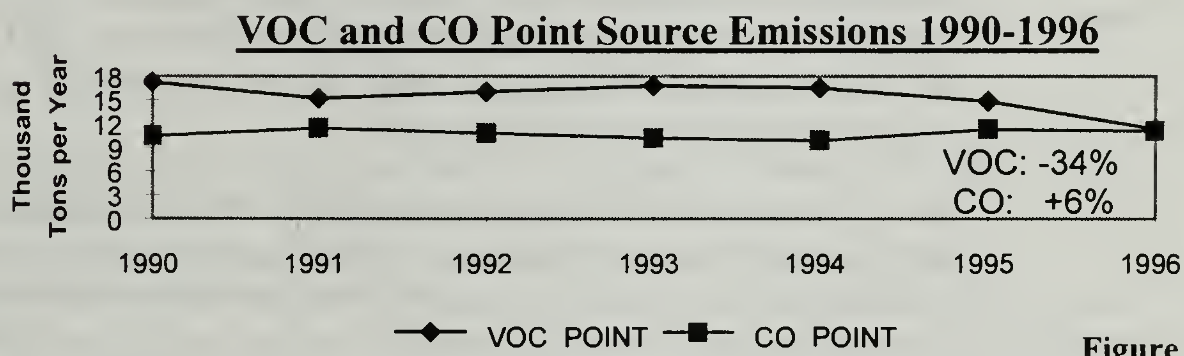


Figure 60

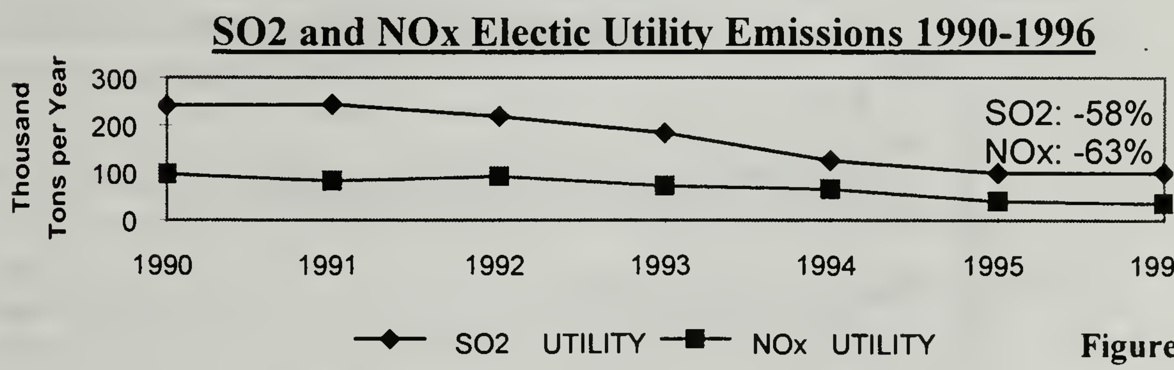


Figure 61

Continued on next page

VOC and NOx emissions sources

VOC and NOx emissions are produced from the source categories described below:

- Point: a stationary source of air pollution, primarily from smokestacks in manufacturing facilities and power plants.
- Area: small point sources too numerous to measure individually, such as those found in gas stations, dry cleaners, and consumer products. Taken in the aggregate they may release a substantial amount of emissions.
- On-Road Mobile: a category of mobile sources that includes common on-road vehicles such as autos, trucks, motorcycles, and buses.
- Off-Road Mobile: a category of mobile sources that comprises engines that are not usually operated on a road, such as construction equipment, boats, snowmobiles, and lawnmowers.

VOC emissions trends

Total VOC emissions were reduced by 10% during the period 1990-1996. Figure 62 shows the composite VOC emissions trends for the period.

On-road mobile VOC emissions were reduced by 28% even though the vehicle miles traveled (VMT) increased 11% during the period. The on-road mobile reduction is attributed to the Federal Motor Vehicle Control Program, the California Low Emission Vehicle Program (adopted by Massachusetts in 1995), the Basic Inspection and Maintenance (I/M) Program, Stage II vapor recovery for gas stations, and reformulated (lower volatility) gasoline.

The off-road mobile emissions increased by 30%. This is likely due to a revision of the Non-Road Emission Estimation Model used to calculate emissions for 1996. The USEPA did not require emissions for 1990 and 1993 to be recalculated.

Composite VOC Emissions 1990-1996

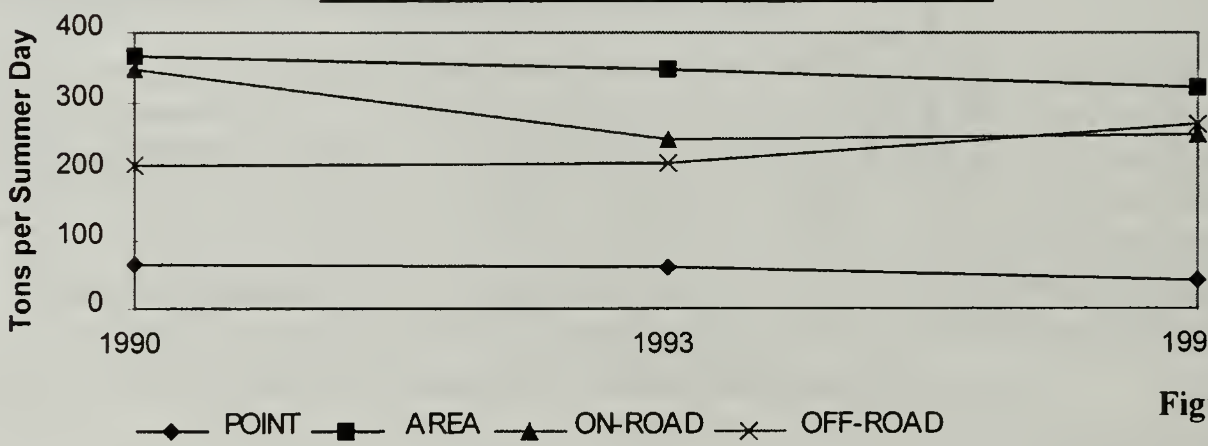


Figure 62

Continued on next page

NOx emissions trends

Total NOx emissions increased by 4% during the period 1990-1996. Figure 63 shows the composite NOx emissions trends for the period.

Point source emissions, primarily electric utilities, were reduced by 51% for this period. On-road and off-road mobile emissions increased by 22% and 61% respectively. The on-road increase is attributable to the 11% increase in VMT. Also, the 1990 to 1996 on-road mobile source controls targeted VOC emissions, and therefore had little effect on NOx emissions. NOx controls for mobile sources have been put in place more recently, and their effect will be reflected as the vehicle fleet turns over. The off-road increase resulted from the revised Non-Road Emission Estimation Model used to calculate emissions for 1996.

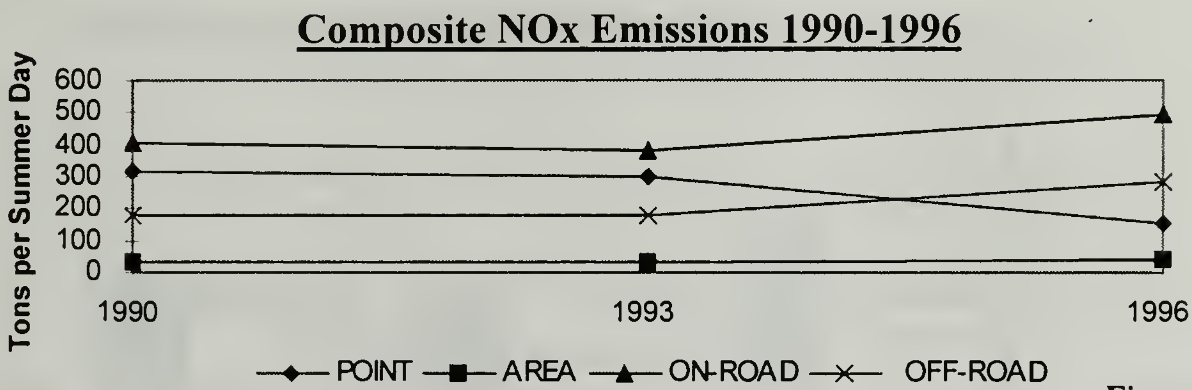


Figure 63

CO emissions trends

Total CO emissions were reduced by 5% during the period 1990-1996. Figure 64 shows the composite CO emissions trends for the period.

On-road mobile emissions decreased by 32% for this period. Because on-road vehicles contribute the lion's share of CO emissions, the decrease in emissions offsets the 47% increase in off-road emissions. Again, this off-road increase in emissions is due to the revised Non-Road Emission Estimation Model used to calculate emissions for 1996.

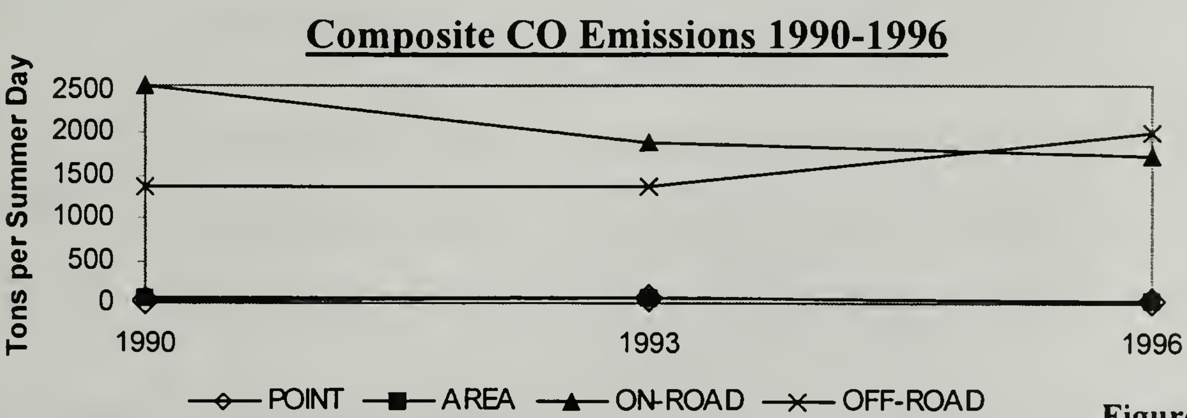


Figure 64

Continued on next page

On-road mobile source emissions trends

Figure 65 shows the 1990-1996 trends for on-road mobile VOC and NOx emissions, together with daily vehicle miles traveled (DVMT).

The VOC emissions decreased by 28% despite an increase of 11% in DVMT. This is a reflection of the effective on-road mobile source control programs that were instituted during the period.

NOx emissions increased by 22%, because the on-road mobile source controls had been targeted toward VOC reduction. NOx controls for mobile sources have been put in place more recently, and their effect will be reflected as the vehicle fleet turns over.

On-Road Mobile Emissions and DVMT

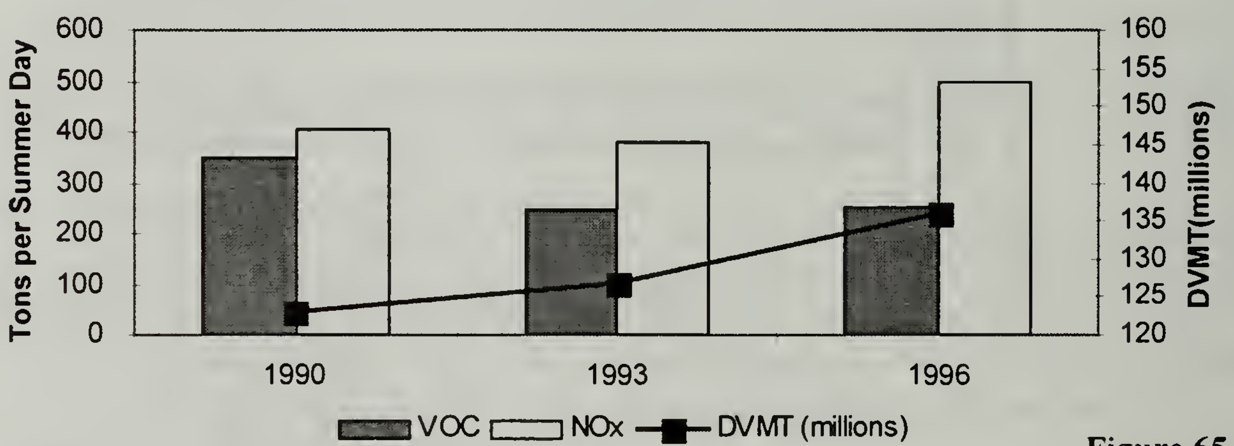


Figure 65

DVMT = daily vehicle miles traveled

Appendix A: Public Site Location Coordinates

CITY SITE LOCATION	AIRS CODE	UTM ZONE	LOCATION COORDINATES UTM (East) & (North) LATITUDE & LONGITUDE
ADAMS Mt. Greylock Summit	25-003-4002	18	UTM(East)650160 (North)4721890 LAT +42:38:12 LONG -73:10:07
AGAWAM 152 Westfield St.	25-013-0003	18	UTM(East)692120 (North)4659040 LAT +42:03:42 LONG -72:40:41
AMHERST N. Pleasant St.	25-015-0103	18	UTM(East)703800 (North)4696975 LAT +42:24:01 LONG -72:31:25
BOSTON Kenmore Square 590 Commonwealth Ave.	25-025-0002	19	UTM(East)327095 (North)4690373 LAT +42:20:54 LONG -71:05:57
BOSTON Fire Headquarters Southampton St.	25-025-0012	19	UTM(East)329584 (North)4688213 LAT +42:19:46 LONG -71:04:06
BOSTON Sumner Tunnel East Boston	25-025-0016	19	UTM(East)332000 (North)4692500 LAT +42:22:07 LONG -71:02:25
BOSTON 340 Breman St. East Boston	25-025-0021	19	UTM(East)333008 (North)4693531 LAT +42:22:41 LONG -71:01:42
BOSTON Fire Station 200 Columbus Ave.	25-025-0024	19	UTM(East)329406 (North)4690316 LAT +42:20:55 LONG -71:04:16
BOSTON 1 City Square Charlestown	25-025-0027	19	UTM(East)330090 (North)4693015 LAT +42:22:22 LONG -71:03:49
BOSTON Post Office Square	25-025-0038	18	UTM(East)330840 (North)4691500 LAT +42:21:34 LONG -71:03:15
BOSTON Harrison Ave. Roxbury	25-025-0042	19	UTM(East)328394 (North)4688242 LAT +42:19:46 LONG -71:04:58
BROCKTON 120 Commercial St	25-023-0004	19	UTM(East)333300 (North)4660379 LAT +42:04:47 LONG -71:00:55
CHELSEA Soldier's Home Powder Horn Hill	25-025-1003	19	UTM(East)332910 (North)4696126 LAT +42:24:06 LONG -71:01:52
CHICOPEE Westover Air Force Base	25-013-0008	18	UTM(East)701792 (North)4674012 LAT +42:11:39 LONG -72:33:22
EASTON Borderland State Park	25-005-1005	19	UTM(East)322200 (North)4658820 LAT +42:03:47 LONG -71:08:56
FAIRHAVEN Wood School Scontuit Rd.	25-005-1002	19	UTM(East)343300 (North)4610800 LAT +41:38:07 LONG -70:52:53

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CITY SITE LOCATION	AIRS CODE	UTM ZONE	LOCATION COORDINATES UTM (East) & (North) LATITUDE & LONGITUDE
FALL RIVER Fire Headquarters 165 Bedford St.	25-003-3001	19	UTM(East)320961 (North)4618523 LAT +41:42:01 LONG -71:09:06
FALL RIVER Fire Station Globe St.	25-005-1004	19	UTM(East)319694 (North)4616888 LAT +41:41:07 LONG -71:09:59
FITCHBURG Fitchburg State College 67 Rindge St.	25-027-2004	19	UTM(East)271158 (North)4719399 LAT +42:35:42 LONG -71:47:21
HAVERHILL Consentino School Washington St.	25-009-5005	19	UTM(East)327700 (North)4736400 LAT +42:45:46 LONG -71:06:21
LAWRENCE Storrow Park High St.	25-009-0005	19	UTM(East)324221 (North)4730569 LAT +42:42:34 LONG -71:08:47
LOWELL Old City Hall Merrimack St.	25-017-0007	19	UTM(East)310489 (North)4723770 LAT +42:38:42 LONG -71:18:42
LYNN Lynn Water Treatment Plant 390 Parkland St.	25-009-2006	19	UTM(East)337855 (North)4704157 LAT +42:28:28 LONG -70:58:21
NEW BEDFORD YMCA 25 Water St.	25-005-2004	19	UTM(East)339500 (North)4610110 LAT +41:37:43 LONG -70:55:36
NEWBURY US Department of the Interior Sunset Boulevard	25-009-4004	19	UTM(East)352040 (North)4738800 LAT +42:47:22 LONG -70:48:33
PITTSFIELD Silvio Conte Federal Building 78 Center St.	25-003-5001	18	UTM(East)643496 (North)4701187 LAT +42:27:06 LONG –73:15:18
QUINCY Fire Station Hancock St.	25-021-0007	19	UTM(East)332391 (North)4682065 LAT +42:16:29 LONG -71:01:57
SPRINGFIELD Howard School 59 Howard Street	25-013-0011	18	UTM(East)699454 (North)4663358 LAT +42:05:56 LONG -72:35:17
SPRINGFIELD Liberty St.	25-013-0016	18	UTM(East)699140 (North)4664480 LAT +42:06:32 LONG -72:35:29
SPRINGFIELD Longhill St.	25-013-1009	18	UTM(East)700185 (North)4661896 LAT +42:05:08 LONG -72:34:47

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Appendix A: Public Site Location Coordinates, Continued

CITY SITE LOCATION	AIRS CODE	UTM ZONE	LOCATION COORDINATES UTM (East) & (North) LATITUDE & LONGITUDE
SPRINGFIELD 1586 Columbus Ave.	25-013-2007	19	UTM(East)699150 (North)4663534 LAT +42:06:02 LONG -72:35:30
STOW U.S. Military Reservation	25-017-1102	19	UTM(East)295450 (North)4698475 LAT +42:24:49 LONG –71:29:09
SUDBURY Nat. Wildlife Refuge Water Row Rd.	25-017-1801	19	UTM(East)303344 (North)4695074 LAT +42:23:06 LONG -71:23:20
TRURO Cape Cod National Park Fox Bottom Area	25-001-0002	19	UTM(East)415100 (North)4647381 LAT +41:58:33 LONG -70:01:29
WALTHAM U. Mass Field Station Beaver St.	25-017-4003	19	UTM(East)317750 (North)4694520 LAT +42:23:01 LONG -71:12:50
WARE Quabbin Summit	25-015-4002	18	UTM(East)719712 (North)4686127 LAT +42:17:54 LONG -72:20:05
WEST SPRINGFIELD Fire Station Van Deene St.	25-013-5003	18	UTM(East)696403 (North)4663920 LAT +42:06:17 LONG -72:37:29
WORCESTER U. Mass Medical Center 419 Belmont St.	25-027-0013	19	UTM(East)272392 (North)4683693 LAT +42:16:26 LONG -71:45:36
WORCESTER Worcester Airport	25-027-0015	19	UTM(East)262797 (North)4684016 LAT +42:11:27 LONG -71:52:34
WORCESTER YWCA 2 Washington St.	25-027-0016	19	UTM(East)269108 (North)4682163 LAT +42:15:33 LONG -71:47:57
WORCESTER Fire Station Central St.	25-027-0020	19	UTM(East)269152 (North)4683021 LAT +42:16:02 LONG -71:47:56
WORCESTER Grafton and Franklin Sts.	25-027-0022	19	UTM(East)269599 (North)4682294 LAT +42:15:39 LONG -71:47:36

Appendix B: Industrial Site Location Coordinates

REPORTING ORGANIZATION CITY SITE LOCATION	AIRS CODE	UTM ZONE	LOCATION COORDINATES UTM (East) & (North) LATITUDE & LONGITUDE
ATLANTIC GELATIN Stoneham (Hill St.) Hill Street	25-017-1701	19	UTM(East)326462 (North)4704385 LAT +42:28:28 LONG -71:06:40
BOSTON EDISON Boston Long Island	25-025-0019	19	UTM(East)337595 (North)4686595 LAT +42:19:00 LONG -70:58:15
BOSTON EDISON Dorchester Dewar Street	25-025-0020	19	UTM(East)330548 (North)4685952 LAT +42:18:34 LONG -71:03:22
BOSTON EDISON East Boston Breman Street	25-025-002[illegible]	19	UTM(East)333008 (North)4693531 LAT +42:22:41 LONG -71:01:42
BOSTON EDISON South Boston East First Street	25-025-0049	19	UTM(East)331871 (North)4690009 LAT +42:20:46 LONG -71:02:28
HAVERHILL PAPERBOARD Haverhill Nettle School	25-009-5004	19	UTM(East)331385 (North)4737365 LAT +42:46:20 LONG -71:03:40